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No. 2 Original.

In the Supreme Court of the United States

OCTOBER TERM, 1917.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,

v.

THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

On Argument For Injunction

BRIEF ON BEHALF OF THE PEOPLE OF THE STATE OF NEW YORK.

MERTON E. LEWIS,
Attorney General of the State of New York.

WILLIAM J. O'SULLIVAN,
Special Counsel.

DISPATCH PRESS, Inc., NEW YORK

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No. 3 Original.

In the Supreme Court of the United States.

OCTOBER TERM, 1917.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,

v.

THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

Statement of Fact.

The Passaic Valley Trunk Sewer project, which the People of the State of New York seek to restrain, is designed to gather the sewage and trade wastes from over 103 square miles in the Passaic Valley, in the State of New Jersey, from 37 municipalities and townships, and discharge it in the main ship channel in the Upper Bay of New York, where the tidal currents will cause it to surround and pollute the shores and waterfronts of the City of New York.

The drainage basin of the Passaic River is over 949 square miles. The evidence based on record in this suit proves that the Passaic River is the most polluted body of water on the American Continent. The conditions in this river became so intolerable

that the legislature of the State of New Jersey undertook to furnish remedial measures as early as 1896, and finally passed Chapter 10 of the Laws of 1907, creating the Passaic Valley Sewerage Commission, with authority to build this immense trunk sewer which the People of the State of New York are seeking to restrain.

In 1908 the Passaic Valley Sewerage Commission applied to the Federal Government for a permit for a trunk sewer outfall, to discharge 360 million gallons of this septic filth each day in New York Bay in the vicinity of Robbins Reef Light, in the main ship channel, and within a short distance of the boundary line between the State of New York and the State of New Jersey.

The applicants for this permit were given hearings before the Harbor Line Board beginning December 9, 1908, and the permit was granted for a tunnel under Newark Bay, the Bayonne Peninsular and part of New York's Upper Bay to the main ship channel.

The complainants' bill of complaint was filed October 17, 1908. The hearings before the Harbor Line Board on the application for the permit began December 9, 1908.

In January, 1909, and after the granting of the permit by the Federal Government, the Department of Justice on behalf of the United States Government, moved for permission to intervene as complainant in the suit instituted by the State of New York against the State of New Jersey and the Passaic Valley Sewerage Commissioners. The motion of intervention was granted on the ample presentation by the Department of Justice of the unsatisfactory conditions incident to the issuance of the trunk sewer permit. On the execution of stipu-

lations subsequently, which were framed in the interests of the navigable channels in New York Harbor, the Department of Justice withdrew as an intervenor.

At the hearings before the Harbor Line Board witnesses for the State of New Jersey and the Passaic Valley Sewerage Commissioners testified to the urgent necessity for cleansing the filthy condition of the Passaic River by removing this vast amount of septic waste to New York Bay, where it will create a permanent and menacing nuisance to the citizens of the State of New York.

At the hearings before the Harbor Line Board the only question presented was the obstruction to navigation.

Mr. Francis Child, counsel for the Passaic Valley Sewerage Commission, "speaking for the Commission, I have this to say" (Pages 2908-9, folios 11-12, vol. 4 of this record):

> "The lamentable conditions of the Passaic River on account of its filth have been such and is such that for the last eleven years the subject of some feasible project for the cleansing of the river has agitated the public mind. The Passaic River is now and has been for years past little more than an open sewer. • • • The stench arising from the river is such that property • • • has been so seriously affected that its salability has been almost destroyed.
>
> • • • • • • •
>
> "I propose to discuss entirely the question of obstruction to navigation. • • • As I understand it, the province of this Board, the peculiar jurisdiction of the Board, is to see to it that navigation is not interfered with • • •." (Page 3051, fol. 303, vol. 4.)
>
> • • • • • • •

"The question which you are called on to determine as I understand it is whether this proposed work will be an obstruction to navigation." (Page 3054, fol. 311, vol. 4.)

• • • • • • •

"The condition, as you heard it described here, is terrible, and ought to be abated with reasonable celerity. Now, to hold us back until the Supreme Court of the United States, acting with reference to the litigation of other questions, should render this decision, would be, gentlemen, I submit to you, gentlemen, tantamount to a denial of justice." (Page 3055, fol. 311, vol. 4.

• • • • • • •

"Now, it may be that at first thought it will appear that it would be discourteous to the United States Supreme Court to anticipate their action. Now, as against that, I have this to say: That we were first in the field." (Page 3055, fol. 312, vol. 4.)

Mr. Edlow Harrison, Chief Engineer for the Passaic Valley Sewerage Commission, testifying in favor of the "application" before the Harbor Line Board, stated:

"At first blush it seems to be quite a proposition to ask permission to do what we are asking to do. Yet any New Yorker • • • will ask himself why they should be at present opposed to this plan." (Page 3039, fol. 279, vol. 4.)

He also stated:

"This whole territory is building up. It is thickly populated as are all other territories around New York City." (Page 2913, fol. 19, vol. 4.)

At that hearing before the Harbor Line Board there were those who made protest against the

granting of the permit to the Passaic Valley Sewerage Commission for their dangerous experiment. Among those was Mayor Coleman E. Kissam, representing the City of Orange, New Jersey, who testified:

> "If New York Harbor is to become so vile in the course of a reasonable time that it will cause disease, be offensive, become filled up and the people will have to stop sewage going into New York Harbor, it seems to me very unfair to us to tap the smaller towns to a point where it means almost absolute penury in order to experiment with this sewage disposition system into deep water which is entirely unnecessary." (Page 3033, folios 267-8, vol. 4.)

When the permit was granted to the Passaic Valley Sewerage Commissioners for the trunk sewer outfall which was to abate the loathesome nuisance of the Passaic River by transferring it to New York's Upper Bay, the State of New York created the New York Bay Pollution Commission to investigate and report whether our harbor waters could assimilate the enormous burden of septic filth which it was contemplated to discharge at Robbins Reef in New York Bay. This commission was instructed to confer with the New Jersey authorities with a view to co-operation in effort to solve the sanitary problems involved. Conferences were had with the Passaic Valley Sewerage Commission and communications were sent to the New Jersey State Board of Health, but no aid was secured and co-operative solution was rejected.

The New York Bay Pollution Commission made its report to the Legislature of the State of New York and recommended the creation of a larger commission, with greater scope and facilities, to continue the investigation and to make further

effort to secure co-operation from the Passaic Valley Sewerage Commissioners and the State authorities of New Jersey in averting a common danger, not only to the health and property interests of the citizens of metropolitan New York but of the New Jersey riparian communities on upper New York Bay. Thereafter the State of New York created the Metropolitan Sewerage Commission and directed the City of New York to furnish appropriations and facilities for extensive scientific investigation of the sanitary problems and dangers involved.

The Metropolitan Sewerage Commission was directed to seek conference and co-operation with the New Jersey authorities and succeeded in securing assent for meetings on three occasions. At these meetings the Passaic Valley Sewerage Commission's representatives declined proffers of aid in joint investigation of the menacing sanitary problems, and all further efforts to secure co-operation by the Metropolitan Sewerage Commsision were frustrated.

Thereupon the State of New York, through its Attorney General, was forced to institute this suit in its efforts to protect the health and preserve the property of its citizens from both pestilence and destruction.

The Passaic Valley sewerage project contemplates the operation and maintenance of a mammoth trunk sewer of over twenty-six miles in length, designed to transport the organic filth and trade refuse from thirty-seven municipalities and townships in the Passaic Valley watershed. It is proposed to discharge this putrescent menace at the rate of over 360 millions of gallons per day into Upper New York Bay, where its septic factors will

continuously endanger a dense community in the City of New York with recurring pestilence.

In the presentation of the evidence comprised in this record facts have neither been suppressed, exaggerated or minimized. These facts were gathered, testified to and interpreted by great scientists from many states, primarily in the interests of sanitary science and progress. A large measure of original scientific work is embodied in this record, together with the most complete scientific series of investigations for the solution of the sanitary questions presented. The most eminent leaders in chemistry, bacteriology, sanitation, bio-chemistry, sanitary engineering and kindred sciences have contributed their knowledge and services towards averting the catastrophe. The burden entailed in assembling this evidence is justified by the incalculable injuries inherent in a project which imperils the health and welfare of millions of our citizens and the commercial pre-eminence of the greatest port of entry in the United States.

POINTS.

I.

Quarantine laws are established for the protection and promotion of the public health (*Gibbons* v. *Ogden*, 9 Wheat., 203).

"Salus populi est suprema lex" (13 Coke 139).

The defendants admit in their answer (page 29, fol. 51, vol. 1) that that part of the complaint known as Schedule A is "a true copy of the said compact or agreement," entered into by and between the State of New York and the State of New Jersey. In the year 1833 this compact or agreement was entered into by and between the aforesaid states through commissioners appointed by each state respectively. This compact was ratified by the legislature of the State of New York by Chapter 8 of the Laws of 1834, passed on February 5, 1834. It was ratified by the legislature of the State of New Jersey by an act passed February 28, 1834, and was approved by Congress by an act passed June 28, 1834, constituting Chapter 126 of the Laws of 1834.

Article III, Chapter 8, Laws of 1834 of New York, sets forth:

> "ARTICLE THIRD. The State of New York shall have and enjoy exclusive jurisdiction of and over all the waters of the Bay of New York, and of and over all the waters of Hudson River * * * and of and over the lands covered by the said waters to the low-water mark on the westerly or New Jersey side thereof * * *."
>
> * * * * * * *

"2. The State of New Jersey shall have the exclusive jurisdiction of and over the wharves, docks and improvements made, and to be made, on the shore of the said State, and of and over all vessels aground on said shore or fastened to any such wharf or dock; except that the said vessel shall be subject to the quarantine or health laws, and laws in relation to passengers, of the State of New York, which now exist or which may hereafter be passed."

Chapter 8 of the Laws of 1834 of the State of New York was passed on by this high tribunal in 1908, and the court's ruling, as summarized in the syllabus, is in part as follows:

"Under the agreement of 1833 between the States of New York and New Jersey, 4 Stat. 708, while exclusive jurisdiction is given to New York over the waters of the Hudson River west of the boundary line fixed by the agreement, the land under such waters remained subject to the sovereignty of New Jersey and the jurisdiction given to New York over the waters do not exclude the sovereign power of New Jersey to tax such land,—nor does an exercise of that power deprive the owner of the land of his property without due process of law.

"This Court in construing a compact between States will hesitate to reach a conclusion different from that reached by the highest courts of both States. 43 Vroom 311 affirmed."

Central R. R. Co. of N. J. v. *Jersey City*, 209 U. S., 473.

Chapter 8, Laws of 1834 N. Y., had been passed upon by the Court of Appeals of New York. The court as summarized in the syllabus held:

"The State has exclusive jurisdiction over the waters to low water mark on the New Jersey shore, and over ships, vessels and crafts of

every kind afloat in the bay of New York and Hudson River south of Spuyten Duyvil Creek for quarantine or health purposes, the protection of passengers and property, to secure the interests of trade and commerce, and to preserve the public peace. It is a qualified and limited jurisdiction for police and sanitary purposes and to promote the interests of commerce."

People of the State of New York, Respondents v. *Central R. R. of New Jersey*, Appellants, 42 N. Y., 283.

In 1891 this law was again ruled on by the Court of Appeals of the State of New York and, as summarized in the syllabus, states:

"While by the compact made in 1833 between the States of New York and New Jersey, the middle of the North River is declared to be the boundary between the two states, yet as by it (Art. 3) exclusive jurisdiction of and over all waters of the bay of New York and of the Hudson River, within certain limits, is given to the State of New York. That State has jurisdiction to pass a law subjecting persons to liability for certain acts done in the waters embraced in those limits, although within the boundaries of New Jersey, as so fixed.

* * * * * * *

"It appears that the defendants discharged into the waters of the North River, at a point about one-fourth of a mile from the Jersey shore and within the limits specified in the compact, dredgings from a slip, HELD, that the State of New York had jurisdiction to enact the provision and that defendants were liable to the penalty prescribed for its violation."

Cornelius Furguson, Respondent v. *P. Sanford Ross, et al.*, Appellants, 126 N. Y., 439.

The defendants in their answer (pages 29-30, fol. 51) admit that the complainants have "police control over the said waters for the enforcement of proper quarantine regulations."

In the exercise of that police power and for the proper sanitary control of the harbor waters of the Port of New York, and for the protection and preservation of the public health, and particularly for the health, comfort and welfare of citizens resident on the *ripa* of New York's Upper Bay, these complainants pray for injunctive relief against the State of New Jersey and the Passaic Valley Sewerage Commissioners.

Professor William T. Sedgwick, of the Massachusetts Institute of Technology, a foremost sanitarian of our country and a scientist of international high repute, describes the area that the Passaic Valley Sewerage Commission contemplates inundating with this river of filth. He testified (pages 2256-7, folios 3276-3277, vol. III):

> "The Metropolitan area of New York and New Jersey is already a vast human ant hill teeming with one of the greatest commercial and industrial populations on the face of the globe. The health, comfort and convenience of this huge mass of human beings requires that every practical and reasonable sanitary safeguard shall be thrown around it. Vast sums have already been appropriated for its safe and proper water supplies and much greater sums will be soon required to prevent its bays and rivers from becoming putrifying, nauseating and dangerous bodies of sewage."

Professor Earle B. Phelps, an eminent sanitarian and bio-chemist who had worked for over a year and a half in making bacterial determinations

and oxygen analyses of our harbor waters to determine their capacity to struggle against this flood of filth, testified (page 1635, folio 2419, vol. III):

> "This great commercial center of the New World depends upon the Harbor as the very heart of its activity. * * * This Harbor is being destroyed and will, if nothing is done, reach a condition which is best exemplified in that of the Passaic River, a black, foul smelling body of water. The Upper Bay will be destroyed."

Mr. Desmond FitzGerald, an eminent consulting and sanitary engineer, of great experience, testified (page 1575, folio 2335, vol. III):

> "For a distance of several miles the sewage discharged at Robbins Reef will be perceptible."

Professor Charles-Edward Amory Winslow, Professor of Biology and Consulting Expert on Sanitary Science, testified (page 1653, folio 2446, vol. III):

> "The discharge of several million gallons of sewage at Robbins Reef will undoubtedly produce an injurious effect upon the health of the community using the harbor and an effect upon the health of persons using vessels in the harbor waters * * * for when that water is polluted or infected there is danger of disease."

And again, page 1652, folio 2444, vol. III:

> "The disease bacteria discharged from the Passaic Valley Sewer will persist for a time in the harbor and some of them will be carried to considerable distances so as to increase the danger."

Doctor E. Kuichling, a sanitary engineer who received scientific training in several countries, testified (page 1322, folio 1975, vol. II):

"The pollution of the atmosphere in the warm season from the oscillating fields of sewage due to the continual discharge of the proposed large volume at Robbins Reef Light—a volume of sewage unusually large being far greater than any like discharge at any other outlet."

The results of such atmospheric pollution was testified to by Prof. William P. Mason of the Rennsaeler Polytechnic Institute (page 2002, folios 2912-3, vol. III) as "lowering the vital resistance whereby invading pathogenic germs coming from other sources can secure a firm lodgment in the body and induce disease."

Prof. Olin H. Landreth, a sanitary and consulting engineer of national standing, testified (pages 2052-3, folio 2982, vol. III):

"There is a well-established belief among medical men and sanitarians that the emanations from sewage and from putrefying organic matter are in general detrimental to health and induce vomiting, diarrhea, prostration, headache, loss of appetite and a general lowering of health."

And he adds:

"The river waters and the tidal waters of New York Harbor are sufficiently polluted so that they would be a menace to health if used on our streets" (pages 832-3, folio 1309, vol. I).

That this sewage menace becomes reality on occasion is evidenced by the testimony of Prof. William B. Sedgwick, of the Massachusetts Institute of Technology (page 2821, folio 4153, vol. III):

"Two of my students, in doing work upon Boston sewage together for investigation, came

down with typhoid fever and careful investigation seemed to exclude all other known causes than the sewage upon which they were working. I therefore was forced to the belief that they contracted the fever from the sewage. Mr. Saville, now a partner of Mr. Rudolph Hering, and Mr. Greeley, now Assistant Chief of the sewage experiment station in Chicago, are the two students."

Prof. Sedgwick adds another case to these two in the following part of his testimony (page 2809, folio 4137, vol. III):

"One of the lighthouse keepers had an attack of typhoid fever last year, which was attributed directly to the sewage coming from the large sewage fields which gave off a strong stench of sewage from the Deer Island outlet in Boston Harbor."

II.

Intolerable public and private nuisances will be created by the discharge of the putrid or septic filth proposed by the Passaic Valley Sewerage Commissioners.

Mr. Theodore Horton, sanitary engineer, consulting and chief engineer, New York State Department of Health, who from 1901 had charge of the designs and the field work in conjunction with Mr. Rudolph Hering relative to the Passaic Valley sewage problem, testified in relation to the proposed discharge (page 2305, folio 3354, vol. III):

"There will be a nuisance created and there will be a menace to health. The nuisance will be more intense in the immediate vicinity of

> the outfall and will extend to a considerable distance beyond it and will be carried to quite distant shores. There will be a nuisance caused by discoloration • • • offensive odors, deposits, diminution of the dissolved oxygen in the water and a menace to health from infection and a menace to health from the reduction of the vital resistance resulting from these offensive odors."

Dr. Robert Spurr Weston, Sanitary Engineer, testified (pages 1986-7, folio 2892, vol. III):

> "The intolerable conditions in the Passaic River will be transferred to New York's Upper Bay by the Passaic Valley Trunk Sewer project. These intolerable conditions will affect shipping interests."

Prof. William P. Mason testified (page 2006, folio 2919, vol. III):

> "The discharge at Robbins Reef will unduly damage the bay water. Its pollution, which is now great, will be made greater, and that pollution growing from all sources will produce a bay-wide nuisance."

Prof. Edward Ellery (Professor of Chemistry), testified (page 2031, folio 2952, vol. III):

> "The discharge at Robbins Reef will deplete the amount of oxygen in the water and that depletion of oxygen will result in a nuisance in all the waters into which the sewage is emptied in New York Bay."

Dr. D. D. Jackson, Sanitary Expert, who had made complete investigations of all harbors and tidal waters on the Atlantic seaboard in relation to sewage discharges, testified (page 2171, folio 3145, vol. III):

> "There is no question but that the Passaic Valley Sewer will add materially to the gen-

eral pollution of the harbor and hasten the time at which a general nuisance will exist."

Prof. Charles-Edward Amory Winslow, consulting expert on sanitary science, testified (page 1655, folio 2448, vol. II):

"The local nuisance at Robbins Reef will begin to manifest itself as soon as the sewer is put into operation. This and the more indirect effect upon the Harbor waters will increase progressively with the increase in the amount of sewage discharged."

Prof. Olin H. Landreth, consulting and sanitary engineer, testified (page 2966, folio 3001, vol. III):

"Whereas, now the Passaic River and the upper portion of Newark Bay produce the deposition of sludge on the bottom, and the sludge nuisance and effluvium nuisances are confined to this territory, in future they will be transferred to the State of New York in the lower portion of New York Bay."

Mr. Desmond FitzGerald, an eminent sanitary engineer, testified (page 1595, folio 2364, vol. III):

"This sewage passing under the influence of the winds and tide would in itself make nuisances in the different parts of the shore."

After he had previously testified (page 1594, folio 2364, vol. III):

"It would constitute a nuisance to people who navigate on the waters and it would be a nuisance in giving out bad smells. It would be a nuisance in lowering the dissolved oxygen around the shore where before there was sufficient oxygen to prevent sewage from being a nuisance."

Mr. Harrison P. Eddy, consulting engineer and sanitary expert, testified (page 1472, folio 2186, vol. III):

"The sewage, especially in the warm season of the year, will have undergone decomposition to such an extent that it will have become putrid and will give rise to highly offensive odors."

Mr. John P. Fox, who had just concluded extensive sanitary investigations in various parts of the United States and in European countries, and who had an extensive knowledge of the conditions of New York harbor waters, testified (page 1205, folio 1833, vol. III):

"Sewage discharged at Robbins Reef will rise rapidly to the surface of the bay as the sewage does from the submerged outlet at Peddocks Island, Boston, and proportionately large fields will be produced of putrefying sewage, • • •."

Mr. John W. Alvord of Chicago, the most eminent sanitary engineer in the Middle West, after months of careful study and investigation of our harbor waters and of the proposed Passaic Valley discharge, swore (page 1893, folio 2772, vol. III):

"I have testified that the sewage from the Passaic Valley sewer will create a nuisance in the waters of New York Bay."

After he had previously testified (pages 1879-1880, folio 2755, vol. III):

"It is impossible to subtract one sewage from the general bulk of sewage and then predicate an estimate of the age of the rest of the sewage, because, as I have remarked, the older sewage always infects the fresher or newer sewage and infects it with its general characteristics as to age very rapidly."

Mr. Emil Kuichling, sanitary engineer, who had graduated from American and European institu-

tions and had national eminence, testified (pages 1321-22, folios 1974-75, vol. II):

> "It is thus seen that the sewage arriving at Robbins Reef will be • • • highly septic and malodorous • • • to infect and induce active decomposition in the remaining large volume of fresher sewage • • •. The liquid proposed to be discharged at Robbins Reef will have a strongly offensive odor • • •. This malodorous sewage will come in contact with water which was previously poluted and therefore unable to absorb the large additional quantity of offensive gases. The latter will accordingly escape into the air from the extensive floating stratum of sewage and a nuisance will be developed."

He also added (page 1322, folio 1975, vol. II):

> "Due to the peculiarities of composition many products of industrial wastes emit extremely nauseating and penetrating odors • • •. The sewage of the district is, therefore, likely to contain an unusually large proportion of trade waste that will cause the development of foul odors."

After an extensive detailed discussion of the factors that would make this intolerable nuisance certain, he testified (page 1814, folio 2667, vol. III):

> "It would create a nuisance that would affect both New York and New Jersey."

Mr. James J. Powers, consulting and mechanical engineer, after forty years experience in building and supervising sewage disposal plants, testified (page 2633, folio 3885, vol. III):

> "The Harbor of Boston has a dilution content of 279 cubic feet per 1,000 of population. In New York Harbor it has only 72 cubic feet dilution per 1,000 of population, or less than one-fourth the dilution in Boston Harbor."

He testified later (page 2645, folio 3906, vol. III):

> "I believe that with the treatment that is described in Exhibit No. 135, that that effluent will be a nuisance in New York Bay and I would be very much opposed to having it go through. • • • I am a resident of the State of New Jersey."

Mr. James H. Fuertes, consulting and sanitary engineer, after several years investigation of New York Harbor conditions and sewerage disposal systems in many cities throughout the United States, South America and Europe, testified (page 1721, folio 2543, vol. III):

> "In my opinion the contemplated discharge of the Passaic Valley trunk sewer outlet in Upper New York Bay in the vicinity of Robbins Reef will have a material effect upon the pollution of the Harbor waters of the Upper Bay, • • • to such an extent as to give rise to nuisances."

Dr. Walter Bensel, an experienced physician and sanitary superintendent of the Department of Health, who had made special studies and investigations of New York Harbor conditions, testified (page 2287, folio 3325, vol. III):

> "The Passaic Valley discharge would create a tremendous offensive condition • • •. There would be so much material that the amount of oxygen content in the waters at present would be unable to produce ordinary decomposition and putrefaction would occur to a large extent."

Continuing his testimony at page 2288, folio 3226:

> "The Passaic Valley discharge added to the existing conditions would produce this nuisance. It would produce a nuisance by itself

wherever it was discharged by leaving decomposible materials on the beaches to putrefy."

The erudite Prof. Sedgwick illustrates the appalling menace threatened by the Passaic Valley Sewerage Commissioners in citing the experience of the City of London in 1858 and 1859, when the River Thames, previously heavily laden with pollution, became overloaded and caused an intolerable nuisance (page 2260-61, folios 3283-84, vol. III):

> "Stench so foul we may well believe had never before ascended to pollute this lower air. Never before at least had a stink risen to the height of an historic event. * * * For many weeks the atmosphere of Parliament Committee Rooms was rendered barely tolerable by the suspension before every window of blinds saturated with chloride of lime and by the lavish use of this and other disinfectants. More than once, in spite of similar precautions, the law courts were suddenly broken up by an insupportable invasion of noxious vapors. The river lost its accustomed traffic and travelers pressed for time often made a circuit of many miles rather than cross one of the city bridges. * * * Dr. Ord reported to the Privy Council in 1859 that in 1859 (the year of the worst stench) steamboat men on the Thames suffered severely from languor, headache, sore throat, nausea, giddiness, mental confusion, etc. In other words, from symptoms of poisoning. In both years the presence of sulphureted hydrogen in the river atmosphere was shown by the rapid blackening of paper soaked in solutions of lead and by the discoloration of the paint of vessels."

III.

Great commercial and property interests would be irreparably impaired by the operation and maintenance of the Passaic Valley trunk sewer.

Mr. A. Foster Higgins, chairman of the Committee on Harbor and Shipping, Chamber of Commerce, City of New York, while representing the Chamber of Commerce of the City of New York, testified (page 2959, folio 114, vol. IV):

> "I come here with the most intense spirit on the part of the Chamber in opposition to this movement. * * * The City of New York cannot preserve her commerce unless she preserves absolutely her condition of a perfectly safe port, a safe port for vessels to visit and for passengers to land, to carry on their transactions in the City of New York. The commerce of the City of New York represents almost the great bulk of the foreign commerce of the United States and you can see how very important a matter it is to all the citizens, not only to the citizens of the City of New York but to the whole citizenship of the United States."

* * * * * * * *

Mr. Higgins gave the following among his reasons for opposition to this project (page 2960, folio 116, vol. IV):

> "This great discharge of sewage should produce in the atmosphere pollution and sickness * * * It would be so disastrous to the commerce of New York."

Captain Charles B. Parsons, president Maritime Association and ship owner, testified (page 2968, folio 134, vol. IV):

> "I am here to oppose what New Jerseymen feel as their interest, yet I am a New Jersey man myself, but I feel, that no man living along the Passaic Valley can divorce himself from the best interest of the City of New York and of its harbor. * * * No man can today in any way injure this harbor if he is doing business with the City of New York without to some extent injuring himself."

Further on Capt. Parsons adds (page 2969, folios 135-6, vol. IV):

> "One of the points which we object to * * * is that it affects the navigable capacity of the harbor and it obstructs it by filling up the heads of piers, shoaling the flats which are used for anchorages. * * * If a vessel painted white be remaining in some of those waters she would become lead-colored in a day and if there two or three days nearly black. * * * It is not only the outside that it affects but it stains the inside. It is absolutely unhealthy for crews of vessels to remain on board while located in the territories or localities where it has been so offensive, and this is continually increasing."

Mr. F. B. Dalzell, Vice-president of the Maritime Association of the Port of New York, Director in the New York Board of Trade and Transportation, Vice-president of the National Board of Steam Navigation and President of the Association for the Protection of Commerce, testified (pages 274-5, folios 478-80, vol. I):

> "The action of the gases and foreign matter in the water is very detrimental to the hulls and sheathing of our boats particularly. * * * there action destroys our paints and affect our metals, I mean this sheathing. The metal that we use on our tugs is copper. * * * Our paint will be discolored and we have great

objections from our employees about sleeping aboard the tugs at night. * * * The crews object to the foul air of foul gases. These putrescent gases affect the paint by turning it black. I know this of my own knowledge. My interest in the harbor waters is not sentimental or scientific, but purely commercial. * * * If the water should ever get much more polluted than it is it would so endanger the hulls of vessels that it would impair the efficiency of this port of entry."

Mr. Arthur Sanford, a contractor, Newark, N. J., testified (page 3047, folio 296, vol. IV):

"I don't want this sewage to come down here and in place of taking the paint off of my Belleville houses to take the paint off my boats, * * * and see the immense mass of filth that it is expected to carry."

Mr. Azel F. Merrell, wholesale oyster business, testified (page 2247, folio 3260, vol. III):

"The sewage that destroyed these oyster beds came down the Arthur Kill and the Raritan River. This sewage not only destroyed the oyster beds but I noticed its effect on the sides of vessels or boats. Any light colored paint it would discolor overnight. The gases rising from the waters would discolor the paint. The discoloration would be quite black."

Mr. J. William Griffin, resident of Jersey City, Superintendent of the Waterworks of the Water Department of Jersey City since 1906, experience extensive in public works construction, etc., testified (page 2873, folios 4226-7, vol. III):

"The discharge of this sewage as proposed at Robbins Reef Light, in accordance with these plans, will affect the health and property of the citizens of Jersey City.

"I appeared voluntarily in this case to protest against the discharge of this sewage into New York Bay on the ground that it will create a nuisance in the waters of the bay which will seriously affect the business interests, the property interests and the health of Jersey City. * * * I know now that the sewage from these towns creates a nuisance in the Passaic Valley affecting the health and property of the citizens therein and that this nuisance is the chief reason why the cities in the Passaic Valley have joined in a plan to carry the same out of the valley through the trunk line sewer proposed by the Passaic Valley Sewerage Commission. I believe that this pipe line will simply transfer the nuisance which exists in the Passaic Valley to the waterfront of Jersey City and the other municipalities on New York's upper bay."

Mr. Griffin, who though an official in the Jersey City administration, apprehended danger from the Passaic Valley sewerage project to property and health in Jersey City, gives the following illuminating answer to a question put by one of the counsel for defendants (page 2875, folio 4229, vol. III):

"Q. (By Mr. Riker) Now, if such an effluent is produced which you say is possible, you think it nevertheless will be a nuisance if discharged into New York Bay?

"A. I do not, but the only thing I say about that is that you would not carry it into New York Bay if you proposed to discharge an effluent of that character."

Dr. Robert Spurr Weston, consulting sanitary engineer, after more than nine months' investigation of the Passaic Valley sewerage project and of the harbor conditions in the Port of New York, testified (page 1971, folios 2872-3, vol. III):

> "The effect upon shipping from the discharge of the Passaic Valley Sewer at Robbins' Reef will be that the turbid grease and other matter would make the waters of the Upper Bay unpleasant for commerce and would make excursions on the harbor unpopular by creating noticeably disagreeable conditions in the largest port of the country, consequently lessening its prestige and depreciating the value of the bay for recreation purposes."

He also explains as the result of his investigations how the injuries to ships from sewage is effected, testifying at page 1951, folio 2847, vol. III:

> "The effect on painted wood and metal of the Passaic Valley sewage: The hydrogen-sulphide evolved would cause paints used to coat wood and iron work to darken in color."

Mr. R. A. C. Smith, Chairman, Committee on Harbor and Shipping of the Chamber of Commerce of the City of New York, Chairman of the New York and New Jersey Joint Commission on Harbor Improvement and Pier Extension for New York Harbor, testified (pages 179-180, folios 340-1, vol. I):

> "I have been connected with commercial business in the City of New York for upwards of thirty-five years, following trade involving an enormous amount of shipments to the South and in addition to that as a ship owner. * * * I feel that I am qualified in answering any questions that involve harbor lines, bulkhead lines and the emptying of the pollution into our river causing the damage which it does, and of the deposits that choke up the channels."

Mr. Henry R. Towne, President of the Merchants Association of New York, member of the

Chamber of Commerce of the City of New York, Vice-President of the American Society of Mechanical Engineers, testified as follows (page 252, folios 445-6, vol. I):

> "There are two phases of this matter bearing on the condition of our harbor, upon the trade and commerce of the port. * * * The second is the sanitary phase affecting the health, comfort and welfare of the people of this great city. This is the side of the subject that appeals especially to me for the reason that for nearly forty years I have been a student of sanitary engineering and have followed the development of that science. * * * One of the worst factors in the situation is the fouling of the waters of the harbor which surround and bisect the greater city. In the earlier days it was permissible for the city to discharge its filth into the adjacent water, but sanitary authorities the world over and one after another of the great cities have found it inpermissible and ultimately intolerable to continue this primitive method and have resorted to other and better methods whereby the vast amount of filth which must be disposed of * * * shall either be carried elsewhere to some safer and less harmful point of discharge, or if that be not feasible, shall then be treated in some way prior to its discharge, so that the effluent * * * shall be practically relieved of impurities."

Dr. Robert Spurr Weston's investigations relative to the Passaic Valley sewerage project from the commercial aspect, he testified to as follows (page 1953, folio 2850, vol. III):

> "Effect on commerce: If the Passaic Valley project be carried out the sewage field would extend across the main channel of the harbor. Incoming and outgoing vessels would

> pass through this field, * * * creating a noticeably disagreeable condition in the largest port of the country. If the polluted harbor water were used for washing decks and in the pantries and galleys of ships, it would be liable to come into contact with food used by human beings and thereby become a possible source of infection."

Prof. Sedgwick sums up these commercial interests in his testimony at page 2257, folio 3277, vol. III, as follows:

> "The port and harbor of New York are the most important port and the greatest harbor of the country and a great center of commence. Many foreign and other steamship lines bring and carry unlimited numbers of passengers; its exports, imports, traffic and trade, foreign and coast-wise, are of the greatest volume and magnitude."

Dr. Weston in his testimony asserts (page 1961, folio 2860, vol. III):

> "The Passaic Valley sewage will injure vessels passing through the main channel in the Upper Bay as occurs now in the Passaic River."

Among the injuries to navigation Professor Sedgwick asserts the following in his testimony (page 2246, folio 3289, vol. III):

> "It will form deposits and will cause shoaling of the channel and blackening of the shore."

He adds at page 2269, folio 3297:

> "The discharge at Robbins Reef will injure United States property."

Mr. Desmond FitzGerald, sanitary and hydraulic engineer, testifies (page 1539, folio 2281, vol. II):

"We have a large inland community which proposes to tunnel under their natural outlet, the Passaic River and Newark Bay, and under the separating land of Bayonne and Jersey City, and discharge their sewage close to the water boundry between New York and New Jersey in such a manner as to do a great injury to the real riparian owners and occupants of valuable property around the shores. • • • That discharge will cause a nuisance."

Prof. Winslow testified (page 1644, folio 2432, vol. II):

"New York Harbor now receives 900,000,000 gallons of sewage per day from about 6,000,000 people. This equals a sewage river 13 miles long, 100 feet wide and 18 feet deep. This volume of sewage deposits 1,500 tons of solid material daily. There is now general pollution of New York Harbor waters and very great local pollution in certain areas."

To this testimony as to present overburdened condition Mr. Desmond FitzGerald sets forth in plain language the Passaic Valley project in its nakedness (page 1541, folios 2285-6, vol. II):

"There is another feature of this tunnel plan which cannot fail to create alarm. The total capacity of the tunnel scheme is more than 400 million gallons daily and that it is probable from the statements of the Passaic Commissioners and their engineers that the full capacity of the tunnel will be utilized on completion of the works. • • • There will flow into the Upper Bay more than 400,000,000 gallons in twenty-four hours. This amount of filth discharged practically at one spot in the Upper Bay will create a local and general nuisance. This amount of sewage concentrated in the neighborhood of Robbins Reef

will create a local nuisance which in a few hours under the action of the winds and currents will be carried to any of the surrounding shores, thus producing a long series of general nuisances in every part of the harbor, which prospectively will increase in intensity as the sewage becomes less diluted and the dissolved oxygen in the Upper Bay is carried lower and lower."

Mr. John W. Alvord, consulting sanitary engineer, testified (page 1896, folio 2776, vol. III):

"The effluent stipulated for will produce deposits in New York Bay of solid matter and it will produce odors due to the putrefaction of organic matters; it will also produce grease and color and it will produce both public and private nuisance."

Prof. Sedgwick sets forth in his testimony the menace to commerce and navigation (pages 2257-8, folios 3278-9, vol. III):

"The construction and operation of the proposed Passaic Valley Sewer will discharge large quantities of putrid matter into the waters of New York Harbor, which matter will oscillate back and forth through The Narrows and through the channels of both upper and lower New York Bay and will tend, in part, to settle, make deposits and eventually shoal and obstruct navigation in those waters, clogging the navigable channels and necessitating the maintenance of dredges, scows and boats to remove said deposits, while the dredges, scows and boats thus required will in themselves obstruct navigation. All this will tend to make the port of New York less serviceable for commerce and less agreeable and comfortable to the people through the offensive and unpleasant odors and the unsightly appearance of the water and of the channels, wharves and

> docks, which will result from the discharge of the sewage in the manner proposed. The sewage so discharged will injure the hulls of vessels and their paint, both exterior and interior, including war ships and other craft belonging to the United States Government; also yachts and pleasure boats."

Mr. James J. Powers, consulting and construction engineer, as the result of his study and investigation of the Passaic Valley sewerage project, their plans and their promises, testifies (page 2638, folio 3895, vol. III):

> "If this effluent, when it issues from the works on Newark Meadows, is an inoffensive, clarified effluent, incapable of offense, it would not be necessary to expend seven million dollars in conveying it several miles to Robbins Reef. If it is inoffensive there can be no objection whatever to discharging it into the Newark Bay."

IV.

Sanitary science can abate the nuisance in the Passaic Valley without afflicting a neighboring community.

Mr. John W. Alvord, consulting sanitary engineer, testified (page 1871, folio 2744, vol. III):

> "The Passaic River and Newark Bay now constitute what might be well called a natural sewage disposal plant by sedimentation, septic action and tidal dilution, and while this natural plant is locally obnoxious, its results as shown by the dissolved oxygen content at the lower end of Newark Bay are more effective than the purification caused by the dilution of the waters of the Hudson River and the tidal

action off the Battery in New York City upon New York City sewage. No problem of this character was ever, in my opinion, finally solved by transferring it out of its natural drainage district into the drainage district of another community where natural conditions are already insufficient to care for the increasing pollution there existing."

Dr. George A. Soper, President of the Metropolitan Sewerage Commission, testified (page 426, folio 733, vol. I):

"The conditions in New York Harbor are not favorable for the disposal of sewage by digesting or assimilation. The constant changing proportions of sea water and land water are prejudicial to the existence of a permanent fauna and flora, and the phenomenon of the under-run indicated that there was an absence of vertical currents which were needed to carry an adequate supply of oxygen to the depths."

Mr. Emil Knichling, after two years of comprehensive investigation of our harbor conditions, and after studying all available data upon tidal and other phenomena relating to the Port of New York, testified (page 1303, folios 1954-5, vol. II):

"Practically the whole of the bottom of Upper New York Bay is covered with black, ill-smelling mud in which particles of sewage origin are distinguishable. In places these deposits have been found to obtain to a depth of over 10 feet. * * * So much decomposible organic matter on the bottom, which is clearly indicated by the bacterial chemical and microscopical examinations which have been made, impair the quality of the overlying water. The gases and soluble products of decomposition are absorbed by the water and to maintain the active process of decomposition oxygen is abstracted from the water. Sewage contains

> much putrescible organic matter in both true and colloidal solution, which is readily oxydized either directly in a chemical manner or indirectly through the action of bacteria which require a definite supply of oxygen."

Among the efforts to solve a problem that is exceedingly complicated by the riparian cities in New Jersey, the following scheme was formulated and is testified to by Prof. Olin H. Landreth, one of the great sanitary engineering authorities in our country (page 415, folio 713, vol. I):

> "In dealing with the problems presented to the New York Bay Pollution Commission we took into general consideration the feasibility of ocean disposal of sewage, and in the report of the Commission we stated that as between two possible general lines of remedy it seemed then that the method of ocean disposal possessed advantages that were preferable. It seemed to be the more feasible and economical of the two methods, economical for the taxpayers of New Jersey as well as of New York."

Mr. L. L. Tribus, a member of the New York Bay Pollution Commission, testified to an alternate scheme (page 317, folio 545, vol. I):

> "I was called on to work out a plan for the sewage of Manhattan. I prepared the plans providing for sewage treatment below the street levels."

Part of the complications of the sanitary problem was testified to by Dr. George A. Soper, President of the Metropolitan Sewerage Commission (pages 468-9, folio 803, vol. I):

> "The Passaic Valley District has been increasing. It is not a fixed area apparently. Practically every succeeding report of the Passaic Valley Sewerage Commission has recommended a larger area."

The following question put by counsel for the Passaic Valley Sewerage Commissioners impels thought. It appears on page 2275, folio 3305, vol. III, and was put to one of the experts who was called upon by the complainants to aid in investigating the problem, and is as follows:

> "If certain waters were very appropriately devoted to cesspool purposes, how would the reduction in dissolved oxygen of those waters be injurious?"

Several communities in the Passaic Valley were anxious to solve their local problem without entering into the Passaic Valley Sewerage scheme. Mr. Harrison P. Eddy, consulting sanitary engineer, of Boston, testified (page 1394, folio 2074, vol. II):

> "I recently made a report to the State Board of Health of New Jersey relative to locating a trickling filter plant for the purification of sewage in the township of North Plainfield. Prior to that I made a report for the cities and towns of East Orange, Montclair, Glen Ridge and Bloomfield; the town of Orange was included. In this report I outlined a method by means of which the sewage of these communities could be purified before it was discharged into any natural stream of water. These methods were to be substituted for the necessity of entering into the Passaic Valley Sewerage project."

Dr. D. D. Jackson, sanitary expert, testified (page 2171, folio 3145, vol. III):

> "The Sewer Department of New York City is making extensive examinations into the quality of the sewage of Manhattan with a view of installing separate devices for sedimentation and screening the sewage, which data is now being collected under my direction."

Any scheme for the relief of New York Harbor waters will be doomed to hopeless failure if the Passaic Valley Sewerage Commission is permitted to operate and maintain its mammoth trunk sewer.

Prof. Sedgwick, after careful study and analysis of this dangerous sewage situation, testified (page 2271, folio 3300, vol. III):

> "The magnitude of New York City's problem and the simplicity of the New Jersey problem indicate that both should co-operate in studying and solving the whole problem."

Mr. John W. Alvord, an eminent sanitary authority from the Middle West, after working many months on this sewage problem and its complications, testified (page 1903, folio 2786, vol. III):

> "This problem is inseparable and common as between the two sovereignties of New York and New Jersey. I do not see how it can be well solved without common co-operation between these two sovereignties. They are both equally interested in the preservation of the purity of the waters of this Harbor. It is a common property in which they are both interested. Proper procedure for these two sovereign states to take on such a question is to agree upon some plan of just and equitable co-operation which, if carried out carefully and conscientiously, will enable both of them to enjoy its advantages equally."

Mr. Alvord's scientific impartiality is disclosed in his testimony at page 1892, folios 2771-2, vol. III:

> "I do not look at it from a local or sectional standpoint. To my mind it is one problem of sanitation which concerns all the surrounding communities of this district under consideration, and as such problem I think it should be treated on broad general advantageous lines

> which should not, in my opinion, tax any one portion of the communities at any excessive rate over any other portion. * * * In so far as relates to the ultimate solution of this problem I do not take into consideration the territorial jurisdictions of the states of New York and New Jersey. * * * I recognize the right in both these sovereign states to obtain a joint participation in the waters of the bay, but I recognize that both must use such right with due regard to the right of each other."

Prof. Sedgwick, after a year's investigation of the entire problem, testified (page 2257, folio 3277, vol. III):

> "Instead of adding to the already too extensive pollutions of New York Bay, the State of New Jersey ought, in my opinion, to join hands with the State of New York and set to work immediately to prevent all further pollution, to the end that these precious bodies of water shall be reserved forever for the real comfort, safety, convenience and sanitary welfare of the vast populations which will soon surround them."

Mr. Desmond FitzGerald, who had the problem under investigation and study for two years, testified (page 1510, folio 2238, vol. II):

> "I have had a good many opportunities for examinations of the waters of New York Harbor and the Passaic River and examined them in detail."

He gives the result in his testimony at page 1538, folios 2279-80, vol. II:

> "In my opinion all should take an equal part in some well considered plan devised after careful thought and acting for the benefit of the whole."

At page 1586, folio 2351, vol. II, he adds:

> "What is in my mind is that all the municipalities should unite and form an intelligent study of the problem as a whole and that no part of it should seek to grab any part of the harbor."

Dr. Daniel Lewis, Chairman of the New York Bay Pollution Commission, Ex-President State Board of Health for eight years, Commissioner of State Board of Health for four years, Master of Art, Doctor of Philosophy, Doctor of Laws, President Medical Society of New York, and President Metropolitan Sewerage Commission, testified at pages 638-9, folio 1022, vol. I:

> "The law directed us to confer with the New Jersey authorities who had charge of the proposed construction of the Passaic Valley Sewer. * * * We had two or three conferences with a part of them and we had a conference with the full commission in Newark. * * * The records of these meetings were kept by the secretary, Mr. A. J. Provost."

Prof. Olin H. Landreth, a member of the New York Bay Pollution Commission, testified (pages 865-6, folios 1356-7, vol. I):

> "Our commission was directed to investigate the condition of pollution of New York Harbor and to recommend what action should be taken; second, to co-operate with similar bodies from the State of New Jersey with a view to ascertain whether by co-operation the large problem of the disposal of the sewage of the entire Metropolitan District might be solved in a way to be effective and without conflict between the two commonwealths. * * *
>
> "There were two or three bodies in the State of New Jersey that we thought perhaps had jurisdiction to co-operate with us—the State

Board of Health, for one, the State Sewerage Commission and the Passaic Valley Sewerage Commission. * * * We rather supposed they might feel that they had authorization to deliberate on questions which affected their jurisdiction, their territory. We knew that their duty was approximately to prevent the pollution of the Passaic River and that that problem had a great deal to do with our general problem, speaking of the problem in general, and that the solution of the problem of the disposal of the sewage in the entire Metropolitan District regardless of State lines. That is a problem in itself. It stands by itself and ought to be treated by itself regardless of State boundaries. We recognized the Passaic Valley as a part of the Metropolitan District."

Prof. Landreth testifies to the sequelae of these conferences (page 869, folio 1362, vol. I):

"No results followed from these conferences. We hoped that results might follow and delayed our work, delayed adopting our final program of work hoping that we might be able to reach a co-operative scheme of investigations by which we should be able to concentrate our activities—our studies—on certain parts of the harbor, and ask New Jersey to concentrate theirs on certain other portions, and thus, perhaps, secure a greater volume of information than we could be able to do separately, but, unfortunately, nothing came of the efforts to co-operate."

Mr. L. L. Tribus, sanitary engineer, member of the New York Bay Pollution Commission, testified (page 312, folio 537, vol. I):

"The members of the New York Bay Pollution Commission had conferences with Passaic Valley Sewerage Commissioners. Our object was to see if some joint action could not be taken by the states of New York and New

Jersey, our two commissions or through a later commission, or through some board assigned for the purpose, to see if unity of action looking to a solution of the sewage problem of the Metropolitan Sewerage District irrespective of state lines. The New York Pollution Commission was specially charged to look into that phase of the question. Our conferences did not result in our securing any real information relative to the plans of the New Jersey project and we found that it was hopeless to expect any development along broader lines."

The comprehensive scope and plan of the investigations are inferred from Prof. Olin H. Landreth's testimony (pages 869-70, folios 1362-3, vol. I):

"We included the territory in New Jersey that the Passaic Valley Sewerage Commission had jurisdiction over in the Metropolitan Sewer District, because it all lies within the natural boundaries of the territory which should have its sewage facilities planned harmoniously, planned in common, even if not by a common single system.

* * * * * * * *

"We did not think that even the added difficulty arising from the fact that there were two states was insurmountable. We hoped a plan might be reached by which in the first place the question should be studied by the two together, working harmoniously together, and as the result of such studies we hoped to settle the question as to what would be necessary to accomplish an harmonious construction or an harmonious series of construction through all parts of the district."

Mr. L. L. Tribus, sanitary engineer and member of the New York Bay Pollution Commission, describes this region in his testimony (page 312, folio 538, vol. I):

> "The district that we call the Metropolitan Sewerage District is the greatest manufacturing center of the world, the sewage has in it a great variety of matter other than that classed ordinarily as sanitary sewage coming from residential districts. This made the sewage problem a very complex one."

Mr. Desmond FitzGerald testified to the work done by the Metropolitan Sewerage Commission (page 1587, folio 2352, vol. II):

> "They have begun a serious study of the present condition in the first place of the harbor waters, and in the next place they have made very extensive surveys and employed a large number of experts to give them advice as to the most necessary and practical way to deal with this great question."

He also testified (pages 1545-6, folio 2293, vol. II):

> "A strong reason for not allowing New Jersey to pour this mass of sewage into New York Harbor near Robbins Reef is because New York is now planning for the proper disposal of the sewage of the whole Metropolitan District, and before any plans can be put into effect the sewage will probably be fifty per cent. greater than in 1910."

Every available effort has been made by the complainants to induce the defendants to abstain from the destructive policy involved in the operation and maintenance of the Passaic Valley Sewerage Commissioners' trunk sewer. The most eminent scientists have been induced to study and advise on the far-reaching problems involved. Even the record in this suit has been compiled until it is encyclopedic on sanitary engineering science and is so informative on the impending dangers from

this insanitary project that it was hoped that the defendants would heed the warnings and seek the co-operation advised by impartial scientists.

This revolting scheme which contemplates inundating the largest industrial population in our country with septic filth, not only menaces with pestilence the health and comfort of our citizens but strikes fatally at the commercial preeminence of the greatest port of entry on the American Continent.

For these reasons your Orators pray that the writ of injunction may issue, and so avert a catastrophe national in its significance.

V.

It is respectfully submitted that the prayer of your Orators should be granted and a writ of injunction issue as prayed for in the Bill of Complaint.

THE PEOPLE OF THE STATE OF NEW YORK,
By MERTON E. LEWIS,
Attorney General.

WILLIAM J. O'SULLIVAN,
Special Counsel.

Office Supreme Court, U. S.
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No. [redacted] Original.

In the Supreme Court of the United States

OCTOBER TERM, 1917.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,

vs.

THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

BRIEF AND ARGUMENT ON BEHALF OF THE DEFENDANTS, THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS.

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No. 3 Original.

In the Supreme Court of the United States.

OCTOBER TERM, 1917.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,

vs.

THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

Brief on Behalf of the State of New Jersey and Passaic Valley Sewerage Commissioners,
Defendants.

Statement of Fact.

The following facts are either admitted by the complainant, or established by its own witnesses, and are not subject to question:

1. The great public work planned by the defendants is to be constructed entirely within the territorial limits of the State of New Jersey.

2. The purpose of the work is to relieve a condition in the waters of the Passaic River constituting a public and private nuisance, which demands immediate abatement.

3. The conditions existing in the Passaic River result from the discharge of sewage into it from the municipalities within the Passaic Valley Sewerage District.

4. The population within this district at the time of the closing of the testimony was approximately seven hundred and fifty thousand.

5. The plans of the defendants contemplate the intercepting of the sewage of the said municipalities by a joint trunk intercepting sewer and branches, the conducting of the sewage to a treatment plant in the City of Newark on the Newark Meadows adjoining Newark Bay, the treatment of the sewage there and the discharge of the effluent through an outfall pressure tunnel within a dispersion area located on the edge of the main ship channel near Robbins Reef, within the territorial limits of New Jersey, the nearest point of the dispersion area to the line dividing the State of New York from the State of New Jersey being more than one-third of a mile.

6. The nearest part of any of the upland of the State of New York to the dispersion area is Staten Island, which is more than a mile distant.

7. The population of the City of New York at the close of taking testimony in this case was about five million.

8. All of the sewage of the City of New York is discharged, untreated, at the surface of the waters of New York Harbor, and immediately at the water's edge.

9. The treatment of the sewage of the Passaic Valley described in the stipulation, Complainant's

exhibit No. 135 (Appendix No. 2 this Brief), will result in the removal of more than fifty per cent. of the solids in the sewage, including all of the coarse material.

10. The discharge of the effluent into New York Bay will be at a depth of forty feet, through at least one hundred and fifty vents, horizontally in the direction of the current in the main ship channel.

11. As a whole the plan of treatment and discharge into the waters is more perfect and complete than any sewerage system discharging into harbor waters now in operation in the world.

12. The sewage of the Passaic Valley discharged into the waters of the Passaic River finds its way through Newark Bay, thence along the shores of Staten Island, to the extent of eighty-four per cent., through the Kill van Kull, into Upper New York Bay, and to the extent of sixteen per cent. through the Arthur Kill into Lower New York Bay.

13. The method of disposal of sewage by the City of New York is the worst possible, so far as its effect on the harbor waters is concerned.

14. In case the methods of treatment described in the stipulation, Exhibit No. 135 for complainant (Appendix No. 2 to this Brief), fail to produce the results guaranteed, further treatment is to be added, which will produce an effluent, which, when discharged into the waters of New York Bay, will result in no nuisance of any kind.

I.

History of the Litigation.

This suit has been pending from October 17, 1908, until this time, a period of nearly nine years. The bill of complaint was filed October 17, 1908, the United States intervened January 4, 1909, the answer of the defendants was filed January 4, 1909, replication was filed November 8, 1909, the stipulation between the United States and the defendants was filed May 16, 1910, and the intervening petition of the United States was dismissed without prejudice on that date. The City of New York applied for leave to intervene December 12, 1910, which application was denied December 19, 1910. The order for the appointment of a commissioner to take testimony was made April 24, 1911. The time to close the testimony was extended from time to time until July 1, 1913. The actual taking of testimony began on June 26, 1911, and ended June 27, 1913. The motion to dismiss for want of prosecution was made and denied November 30, 1913. The time actually used by defendants in taking testimony was less than six months. The delay in bringing this cause to argument is chargeable to the complainant.

II.

The Pleadings.

For the convenience of the Court there is appended to this brief, as Appendix No. 1, an analysis of the bill of complaint and the answer and replica-

tion. The substance of the complaint and answer, stated briefly, is as follows:—

The complaint charges the defendants with planning and intending to divert the sewage of the Passaic Valley Sewerage District, then discharging into the Passaic River, through an intercepting sewer into the waters of New York Bay near Robbins Reef light, and thereby threatening to injure the complainant.

1. *By interfering with contractual rights claimed by it under the compact between New York and New Jersey, ratified in* 1834.

2. *By setting up a continuing nuisance in the waters of New York Bay, which must cause injury to the inhabitants of the State of New York, and particularly the City of New York.*

The answer admits the design and plan of intercepting the sewage of the Passaic Valley Sewerage District, carrying it to treatment works on the Newark Meadows, and discharging an effluent into the waters of New York Bay near Robbins Reef light; but denies that the discharge so intended will be either an infraction of the rights of the complainant under the compact in question or will constitute a nuisance, as alleged in the bill of complaint.

The answer further charges that complainant cannot be heard in a Court of Equity to urge either of these claims, because of its own acts of commission which disqualify it on the ground that it does not come into this Court of Equity with clean hands.

III.

The Issues Raised by the Pleadings.

Is complainant entitled to the injunction prayed for

1. *On the ground that the discharge of the sewer as planned within the territorial limits of New Jersey into the waters of New York Bay threatens*

a. *A violation of rights conferred upon the State of New York by the compact of* 1834.

b. *An irremediable continuing nuisance affecting the inhabitants of the State of New York injuriously.*

2. *Has complainant any standing in a court of equity to ask the relief prayed for, in view of the character of its own conduct and acts in the premises?*

UPON EACH OF THE ISSUES RAISED, DEFENDANTS SUBMIT UNDER THE EVIDENCE AND THE LAW THE ANSWER MUST BE NO.

IV.

The Evidence.

A. The urgent necessity for the purification of the waters of the Passaic River is admitted by the allegations of the bill of complaint, the answer, complainant's brief, and the evidence of every witness who testified with respect to it. Complainant's brief, p. 1, says, "The evidence * * * on record in this suit proves that the Passaic River is the most polluted body of water on the American con-

tinent." While this statement is extreme and not warranted by the evidence, it is nevertheless a fact that the condition of the river is intolerable and requires immediate relief. Some of the witnesses use the term "open sewer," others "an elongated septic tank" in describing the river as it now is.

B. The record further discloses that the problem of purifying the Passaic River has been under consideration by various bodies in the State of New Jersey from 1896 down to the present time. The possible solutions are the following:—

a. Separate treatment of the sewage of each municipality and the discharge of the effluents either into the fresh water streams within the municipalities or into the Passaic River.

b. A joint intercepting sewer, conveying all the sewage of the district to a central treatment plant, and the discharge of the effluent therefrom either into Newark Bay, the Kill von Kull, or New York Bay.

a. Separate local treatment is shown by the evidence to have been under consideration by the City of Paterson, the cities of Orange and East Orange, the towns of Montclair and Bloomfield and the Borough of Glen Ridge. Chapter 10 of the Laws of New Jersey, Session of 1907, a copy of which is annexed to the bill of complaint, discloses that every municipality within the district has the choice of making disposal of its sewage as might seem best to it, provided that it shall no longer discharge sewage or other polluting matter into the waters of the Passaic River after the date fixed by statute. No compulsion is used on any of the municipalities to join in the intercepting sewer

project. It appears, however, by the evidence that fifteen of the municipalities within the district executed the contract for the construction of the sewer, including the City of Paterson. *Record, Vol.* 3, *page* 2625. The action of these municipalities confirms the obvious conclusion that the construction and operation of individual treatment plants efficient to produce an effluent fit to be discharged into fresh water streams or into the Passaic River must be more costly in construction and operation, and less efficient, than the plan submitted by the Passaic Valley Sewerage Commissioners.

b. There is also to be considered the question of the place of discharge of the treatment plant to be located on the Newark Meadows in the City of Newark. Three possible disposals are suggested:

(1) Into the waters of Newark Bay.

(2) Into the Kill van Kull.

(3) Into the waters of New York Bay.

(1) A discharge into Newark Bay would manifestly be more economical than either of the others, but a controlling objection is found in the fact that the average depth of the waters of Newark Bay is only six and one-half feet, which renders these waters most unsuitable for the discharge of any kind of effluent. It also appears from the testimony that the United States authorities refused to grant a permit for such a disposal.

(2) The Kill van Kull is subject to all the objections which are being raised in this suit against New York Bay, besides additional objections because of the character, depth and tidal flow of this body of water as compared with the waters of New

York Bay, and because of the necessary proximity of any discharge point to Staten Island, a part of the State of New York, which is quite as likely to raise objections to this disposal as to the proposed disposal in the neighborhood of Robbins Reef.

(3) These different disposal points have been under discussion and adjudication in the case of *Berdan vs. Passaic Valley Sewerage Commissioners*, 82 *N. J. Equity*, 235 (affirmed 83 N. J. Equity, 340). In this case an injunction was prayed against the defendant to prevent the construction of the outfall tunnel into New York Bay, on the ground that it would constitute a waste of public money, it being contended that the effluent which would produce the results required by the stipulation between the State of New Jersey and the United States Government could properly, safely and economically be discharged into the waters of Newark Bay or the Kill van Kull. The injunction was denied by Vice Chancellor Backes, and the denial was affirmed by the Court of Errors and Appeals for the reasons given by the Vice Chancellor. The opinion says:

> "It is perfectly obvious, even to the lay mind, that New York Bay, because of its great depth and dilution volume, constantly agitated by strong tides and currents of great velocity, is possessed of far greater absorbing and digesting capacity and of oxidizing and mineralizing properties than the shallow and sluggish waters of Newark Bay."

C. The character of the discharge planned and intended to be made from the Passaic Valley Sewer into the waters of New York Bay is not now debatable. Whatever doubt may arise from the alle-

gations of the bill of complaint and of the answer with respect to the character of the proposed discharge has been definitely and finally eliminated by the stipulation between the United States and the State of New Jersey and the Passaic Valley Sewerage Commissioners after the intervention of the United States in this suit, by reason of which stipulation the United States applied for and was granted leave to withdraw its petition of intervention. This stipulation will be found at different places in the record of this case:

a. As part of the proceedings in the cause, Record, Vol. 1, page 110.

b. Exhibit 135 for complainant, Record, Vol. 5, page 4005.

c. Exhibits 6 and 7 for defendants, Record, Vol. 5, page 4619.

For the convenience of the Court a copy of the stipulation is appended to this brief as "Appendix 2."

The second general paragraph of the stipulation reads as follows:

> "Second: The Passaic Valley Sewerage Commissioners further agree with the United States that in the operation of said sewer system at all times the following results shall be secured, either through compliance with the requirements of the immediately preceding paragraphs, or through requisite lawful additional arrangements, viz.:
>
> 1. There will be absence in the New York Bay of visible suspended particles coming from the Passaic Valley sewage.
>
> 2. There will be absence of deposits objec-

tionable to the Secretary of War of the United States in the New York Bay coming from the Passaic Valley sewage.

3. There will be absence in the New York Bay and its vicinity of odors due to the putrefaction of organic matters contained in the Passaic Valley sewage thus discharged.

4. There will be a practical absence on the surface of New York Bay of any grease or color due to the discharge of the Passaic Valley sewage at the dispersion area or elsewhere.

5. There will be no injury to the public health which will be occasioned by the discharge from the said sewer into the Bay of New York in the manner proposed and no public or private nuisance will be created thereby.

6. The absence of injurious effect from said sewage discharge upon the property of the United States situated in the harbor of New York.

7. The absence of reduction in the dissolved oxygen contents of the waters of New York Bay, resulting from the discharge of Passaic Valley sewage, to such an extent as to interfere with major fish life."

A comparison of the above stipulations with the matters charged by complainant in its bill of complaint will demonstrate that the stipulations were designed to meet the charges of the bill of complaint and to overcome the objections so raised to the proposed drainage from the Passaic Valley sewer.

D. While it is manifest that the legal interpretation of the effect of these stipulations is a matter for the determination of this Court, and not for that of expert witnesses, and that no expert testimony

can establish that a public or private nuisance was threatened by the defendants in view of their stipulation that "There will be no injury to the public health which will be occasioned by the discharge from the said sewer into the Bay of New York in the manner proposed, *and no public or private nuisance will be created thereby*," it nevertheless is of interest to note that while substantially every expert witness for the complainant, cross-examined as to the effect of the stipulation, was forced to admit that an effluent producing the guaranteed results could not be injurious to the waters of the Bay of New York, some of the experts persisted in expressing the opinion that a nuisance would nevertheless be created.

It is submitted that with respect to what is planned and intended by the defendants with reference to the discharge into New York Bay, there can hardly be conceived a more solemn declaration of intent than that contained in this stipulation. It is made with the United States Government, the supreme sovereign power having control of the navigable waters of the Bay of New York. It is made a condition for the granting of the permit of the United States authorities, necessary for the construction and operation of the sewer, and the further result of its execution was the withdrawal of the United States as a party to this litigation.

E. The production of an effluent by treatment of the Passaic Valley Sewerage Commissioners which when discharged into New York Bay near Robbins Reef will result as guaranteed in the stipulation is practicable, either

a. By the processes and devices specifically de-

scribed in the first general paragraph of the stipulation; or

b. By additional treatment and devices, which are known and can be applied.

a. As might be expected, the experts for the complainant say that the effluent required to produce the guaranteed results will not be produced by the said processes and devices. No one of them, however, is able to point to an effluent produced by the said processes and devices in actual operation or under conditions similar as to quantity of discharge, volume of water into which it is discharged, and diffusion and dispersion of discharge. Record, Vol. III, 1875. The example most nearly coinciding with the conditions stated described by complainant's witnesses is the discharge from the Metropolitan Sewerage Commission's sewer in Boston Harbor, at Nut or Peddock's Island. While this sewer discharges from only one outlet and vertically into the waters of Boston Bay, complainant's witnesses testify that the results show practically no nuisance or objectionable feature of any kind.

One expert witness, however, was sworn for the complainant, who testified that the discharge of the effluent which will be produced by the specified processes and devices will not create a nuisance in New York Bay. This witness is Rudolph Hering. He was asked, Record, Vol. III, page 2868:

> "Q. Do you mean to say that that you are now of the opinion that the discharge of the effluent as proposed will not produce the results that are guaranteed in Complainant's exhibit No. 135 which is before you?
>
> "A. I am of the opinion that for a while

and for a time—how long I do not know—this discharge as specified here with only slight exceptions that would no doubt be made in the course of developments, will not cause a nuisance, that is, for a certain time, the length of which I do not know."

Page 2869:

"Q. I ask you again whether you have changed your opinion as to the effect of the effluent which will be produced at the proposed pumping station on the Newark Meadows when discharged into New York Bay, as to whether it will or will not for the maximum sewage intended to be conveyed by this sewer, will result as specified in the stipulation which is Complainant's exhibit No. 135?

"A. I don't think that it would cause a nuisance today, just as I have stated before.

"Q. That maximum discharge of 300,000,000 gallons today?

"A. That I am prepared to say today. • • •

"Q. Well, what I want you to answer, Mr. Hering, if you will, is whether or not you have changed your mind as to the result in New York Harbor of an effluent produced as proposed and described in Complainant's exhibit No. 135, whether it will cause a nuisance in New York Harbor?

"A. Not today, as I have already stated."

The somewhat arbitrary conclusion of the expert witnesses of complainant with reference to the efficiency of the processes and devices described in the stipulation is contradicted:

(1) By the inference plainly resulting from the stipulation itself, that the engineers of the United

States were of opinion that the said devices and processes would in fact produce an effluent which when discharged into the waters of New York Bay near Robbins Reef would result as required by the stipulation.

(2) By a like inference that the engineers of the Passaic Valley Sewerage Commissioners believed that the prescribed processes and devices would produce such an effluent, this opinion appearing more formally in the certificate of these engineers, which constitutes exhibit No. 5 for the defendant in this suit; omitted by oversight from the printed record, but stipulated to be used on the argument, a copy of which is for the convenience of the Court appended as "Appendix 3."

(3) By a like inference from the stipulation between the United States and the Bronx Valley Sewerage Commissioners of the State of New York, where the same results are guaranteed as in the New Jersey stipulation, under processes to be adopted by the Bronx Valley Sewerage Commissioners, not specifically described, but guaranteed to result in a reduction of the putrescibility of the Bronx Valley sewage of ten per cent., it being admitted by the expert witnesses of the complainant that the processes and devices described in the New Jersey stipulation will in fact remove more than ten per cent. of the putrescible matter from the sewage of the Passaic Valley.

This stipulation is complainant's exhibit No. 177, Record, Vol. IV, page 4317, and resulted in the discontinuance of the suit pending between the United States and the people of the State of New York and the Bronx Valley Sewerage Commissioners for an injunction against the discharge of the

Bronx Valley Sewer into the waters of the Hudson River.

(4) By the testimony of the expert witnesses of the defendant. Of these, William M. Brown, now chief engineer of the Passaic Valley Sewerage Commissioners, was assistant chief engineer of the Massachusetts Drainage Board from 1890 until 1895, and chief engineer from 1895 until 1912. His testimony will be found in the record, Vol. III, page 2354 et seq. The sewerage works of which he had charge provide for the main drainage of about three hundred square miles of territory surrounding the City of Boston and involving parts of the city itself, and includes twenty-five separate municipalities. The population is approximately one million inhabitants. His practical experience certainly qualifies him to testify as to practical results more fully than any or all of the theoretical experts sworn on behalf of the complainant. It is to be noted that his connection with the Passaic Valley Sewerage Commissioners began in 1912, after the approval of the plans and execution of the stipulation between the United States and the Passaic Valley Sewerage Commissioners. He was asked, Record, Vol. III, page 2358:

> "Q. In your opinion will or will not the effluent produced from the works there specified produce the results which are guaranteed in the stipulation which you have before you?
>
> "A. I think they will, yes, sir.
>
> "Q. As compared with the effluent, or the discharge rather, into the Boston Harbor from the Massachusetts Metropolitan Sewerage District, what in your opinion is the character of the effluent which will be produced from these works?

"A. I think this effluent will be very much more clarified as compared with anything we handle in Massachusetts."

Asa Henry Phillips, whose testimony will be found, Record, Vol. III, page 2321 et seq., is the chief engineer in charge of the sewage treatment and disposal works of the District of Columbia. His testimony is particularly valuable and instructive because of its practical character, and because the results of treatment in the District of Columbia were obtained from a treatment involving only a fractional part of the processes required for the Passaic Valley sewerage. He says, Record, Vol. III, page 2323, in answer to the question:

"Q. What is the discharge from your sewers into the Potomac River?

"A. We have never found the slightest indication of any result from the discharge of sewage at outfall on the shores themselves, that is, no material can be ascribed to discharge from the outfall, the shores are clean and entirely free from any evidence whatever of the sewage discharge.

"Q. What has been your observation, so far as the appearance of the water at the point of outfall, of the different conditions of turbidity and clarity, as you observed them, so far as the influence of the discharge of sewage is concerned?

"A. The water has been so unaffected by the discharge that in the great majority of times it has been very difficult indeed to locate the discharge at all, even in a boat, I mean passing over it and searching for particular parts; with our upward elbow discharge of course it makes a slight—the weight of the water discharging would have a tendency to

make a slight rounding of the surface, but even with that we find it very difficult to locate it in the majority of times. It is free from floating matter, from visible suspended material. It is not affected in color, and there is absolutely no odor so far as I have ever been able to determine, even from a boat directly over the point of discharge."

The whole testimony of this witness is peculiarly valuable from the fact that the discharge from the sewerage system of the District of Columbia nearly approximates the conditions required by the stipulation in question.

General Henry Martyn Robert (Record, Vol. III, 2370), for many years chief engineer of the New York Harbor Line Board, testified that in his opinion the volume of fresh water brought in by each tide was more than sufficient to dilute and disperse the sewage proposed to be discharged from the Passaic Valley sewer, without treatment.

Samuel L. Gray (Record, Vol III, 2383) and George A. Johnson (Record, Vol III, 2445), engineers and sanitarians of wide experience, both agree with these practical witnesses in saying that the results agreed to be produced by the effluent will, in fact, be produced by the processes and devices described in the stipulation.

This conclusion, at least, seems to be fully justified, namely, that the probabilities are strongly in favor of the view that the results guaranteed will be obtained through the processes and devices specifically described in general paragraph 1 of the stipulation in question.

b. Whatever may be the result in opreation of the processes and devices described in general paragraph 1 of the stipulation in question, it is clear

that the treatment so indicated is the minimum required from the Passaic Valley Sewerage Commissioners, and that if it does not produce the results guaranteed in the second general paragraph of the stipulation the Commissioners must add *the requisite lawful additional arrangements*. The said second general paragraph of the stipulation begins as follows:

> "The Passaic Valley Sewerage Commissioners further agree with the United States that in the operation of said sewer system at all times the following results shall be secured, either through compliance with the requirements of the immediately preceding paragraphs, or *through requisite lawful additional arrangements*."

Cross-examination of complainant's experts developed the fact that every one of them in his consideration of the effect of the stipulation assumed that no further treatment would be given to the sewage than that specifically described in the stipulation; and upon that assumption they all testified on direct examination that the results guaranteed by the Commissioners would not be produced. Their cross-examination further developed admissions on the part of all of them that there are additional processes known and actually in operation which, if applied to the sewage at the treatment works, would certainly produce an effluent of a character to result when discharged into the waters of New York Bay as guaranteed in the stipulation. When asked why they excluded the application of additional processes they made various excuses.

Some of them professed not to understand the meaning of the phrase "through requisite lawful

additional arrangements," claiming that they did not know what might or might not be lawful, but in the end convicting themselves of a willful refusal to accept the natural, reasonable and common meaning of common English words. Others professed to believe that the guaranteed results would not be produced because in their opinion it could not be determined whether objectionable conditions existing in the waters of New York Bay could in fact be identified with the sewage discharged from the Passaic Valley sewer. Others professed to believe that the additional treatment would not be given because of the cost of such treatment, but were unable to suggest any other plan of disposal of the sewage of the district at a less cost. One of them went so far as to say that the stipulation would not be carried into effect for the reason that the City of New York was not a party to it, and could not insist upon its terms. Of the above suggestions it is perhaps worth while to consider briefly the following:

(1) That the State of New Jersey and the Passaic Valley Sewerage Commissioners will be unwilling to apply additional treatment because of the cost of such treatment.

(2) Because the United States will not enforce the stipulation.

(1) The foundation of the first suggestion is an assumption that the State of New Jersey has no real interest in the condition of the waters of New York Bay; or, to put it in another way, that New York Bay is practically admitted by New Jersey to be the property of the State of New York, and that the designation of it as "My Bay"

or "Our Bay" used by some of the witnesses for the complainant, has a real foundation in fact.

It seems plain enough to require no argument that the interests of the State of New Jersey in the Bay of New York do not differ in kind and hardly in degree from those of the State of New York. The shore line of New Jersey on the Bay is seven miles as compared with thirteen miles for the State of New York. The land under water to the middle of the Bay is the territory of the State of New Jersey. The development of the lands of New Jersey bordering the Bay is as important to that State as the development of the New York lands is to that State. Any condition created in the waters of New York Bay which tends to injure the future development of the surrounding territory is of as much importance to the State of New Jersey as to the State of New York. As a matter of fact, it is beyond doubt that the inhabitants of New Jersey make more actual use of New York Bay than the inhabitants of the State of New York.

It is added by some of the witnesses that in their opinion the cost of the additional treatment will be prohibitive. The use of the term "prohibitive," however, is found to be only relative, and is meant to indicate that in their opinion some other methods of disposal of the sewage of the Passaic Valley could be adopted which would be less costly; but when examined as to what these other disposals might be, are found to be unable to suggest any which would be in any way efficient to produce the desired result.

(2) As to the second reason suggested for the non-performance of the stipulation, it may be said

that the considerations which induced the Attorney General of the United States to intervene in this litigation and in like manner to institute an independent suit in this court against the State of New York and the Bronx Valley Sewerage Commissioners, are unquestionably sufficiently potent to insure prompt action on the part of the United States in case the stipulation is violated by the State of New Jersey or the Passaic Valley Sewerage Commissioners, certainly if conditions even approximating those predicted by some of complainant's witnesses shall appear; and against any action by the United States arising in this manner the State of New Jersey and the Passaic Valley Sewerage Commissioners would be without defense. The permit to operate the sewer is expressly conditioned upon the performance of the stipulation. Failure to perform would be followed by the withdrawal of the permit, and this in turn would necessarily be followed by an injunction against further operation of the sewer. No equity could be urged in favor of the defendants in view of the fact that the stipulation was executed before the sewer was in fact constructed or begun. To insure the detection of even a partial failure to perform the stipulation the third general paragraph thereof covers visitatorial powers upon the United States and its representatives, to inspect and examine the operation of the sewer.

It is therefore submitted that the suggestions under discussion are not worthy of serious consideration. Briefly summarizing the foregoing discussion we submit:

(1) THAT THE AGREEMENT WITH THE UNITED STATES GUARANTEES THAT NO NUISANCE WILL BE PRODUCED BY THE DISCHARGE OF THE EFFLUENT INTO THE WATERS OF NEW YORK BAY.

(2) THAT THE STIPULATION IS CAPABLE OF EXECUTION BY THE PASSAIC VALLEY SEWERAGE COMMISSIONERS.

(3) THAT ITS EXECUTION IS ASSURED BOTH BY THE INTERESTS OF THE STATE OF NEW JERSEY AND BY THE CONTROL OVER IT BY THE UNITED STATES.

F. Some facts appear in the evidence which bear upon the practical interpretation by the States of New York and New Jersey of the scope and effect of the compact of 1834.

Charles A. Van Kuren, Chief Engineer of Jersey City, Record, Vol. III, page 2604 et seq., testifies to the practice of Jersey City in constructing sewers emptying into the waters of New York Bay without request for any permit from the State of New York or any claim on the part of the State of New York of jurisdiction over such discharge.

Thomas H. McCann, a civil engineer having had experience with the sewers of Hoboken, Record, Vol. III, page 2608, testifies that New York City or State never asserted the right to control the discharge into New York Bay on the New Jersey side within a period of practically forty-three years.

John Payne, secretary and engineer of the State Board of Riparian Commissioners of New Jersey, Record, Vol. III, page 2612, testified to the control by the State of New Jersey over the lands under water in New York Bay, including grants

to the United States, the fixing of lines of solid filling, the granting of the fee of the lands under water to private individuals and corporations, and the filling of the lands to the lines of solid filling fixed by the Riparian Commissioners; that no permit or approval was ever asked or received from the State of New York, that no remonstrances from the State of New York or any municipal body in that State have ever been made.

This practice, extending over a great many years, indicates a practical interpretation of the legal effect of the compact of 1834, which accords with the effect of the decisions cited in this brief in the discussion of the legal aspects of the case.

(3) COMPLAINANT HAS NO STANDING IN THIS COURT TO ASK OR RECEIVE EQUITABLE RELIEF FOR THE REASON THAT IT DOES NOT COME INTO THIS COURT WITH CLEAN HANDS.

Three commissions appointed by the State of New York, the first in 1903, have busied themselves for more than ten years and expended more than one hundred and thirty-five thousand dollars in accumulating data, scientific and otherwise, relating to the waters of New York Harbor, including therein the Hudson River, the East River, the Harlem River, Upper New York Bay, Lower New York Bay, New Town Creek, Jamaica Bay, Gravesend Bay, the Gowanus Canal, the Kill von Kull, the Arthur Kill, Newark Bay and the Passaic River. The whole of this matter, including the reports of each of the Commissioners, for the most part immaterial, irrelevant and inadmissible, has been emptied bodily into this case, resulting in

what counsel for the complainant terms an "Encyclopaedic Record," but which we humbly submit is a record remarkable only in extent, bewildering in detail, and for the most part valueless in determining the issues in this cause. The record in fact is inexcusably loaded down with complainant's expert scientific determinations of the salinity of the waters of New York Harbor, their bacterial content, determinations of the amount of free oxygen in the waters, the presence and chemical properties of the muds in the Harbor, the directions and continuance of currents in the water, and various other observations, all of which undoubtedly have an interest, if not a value, in scientific libraries, but do not in fact help in any way to the determination of the issues in this cause. This scientific data is in fact only a translation into technical terms of the results of the admitted acts of the complainant, which Professor Winslow, the witness for the complainant, Record, Vol. II, page 1644, says results as follows:

> "New York Harbor now receives nine hundred million gallons of sewage per day from about six million people. This equals a sewage river thirteen miles long, one hundred feet wide and eighteen feet deep. This volume of sewage deposits fifteen hundred tons of solid material daily. There is now general pollution of New York Harbor waters, and very great local pollution in certain areas."

It further appears from the testimony of complainant's witness, Record, Vol. III, page 1767, that of the sewage entering New York Harbor ninety per cent. is contributed by the City of New

York. It is further testified by complainant's witnesses, Record, Vol. II, pages 1559, 1620, that the City of New York is discharging this vast quantity of sewage without treatment of any kind, even rough screening, at the most objectionable points possible for its discharge, the only excuse for which is the saving of the cost of a proper discharge. The testimony is, Record, Vol. II, page 1209, that all of the sewage is discharged at a point not lower than low water in the Harbor, in part into the slips, in part at the pier heads, in some cases directly under piers used for recreation purposes in the summer time, at points either adjoining or near to free public bathing establishments, at others near oyster beds, from which oysters are taken for food, and that the result of this course of procedure by the City of New York has rendered bathing in the waters of New York Bay, the Hudson, East and Harlem Rivers, not only revolting, but dangerous, has contaminated the oyster beds of the Harbor to such an extent that most of them have been abandoned, has rendered the major edible fish unfit for consumption, so that the "erudite" Professor Sedgwick, Record, Vol. III, page 2276, is compelled to say:

> "That it is not only a disgusting, but a dangerous condition, when Manhattan Island or Staten Island or Coney Island is in fact, as has often been said, 'A body of land surrounded by sewage.'"

Testimony is cited under Part V of this brief given by complainant's witnesses of the results of professional investigation of the conditions of the waters of the Hudson River, New York Bay, the

East River, the Harlem River, the Gowanus Canal and New Town Creek, which discloses such revolting conditions created by the City of New York as to be almost unbelievable. All of the conditions predicted as likely to result from the discharge of Passaic Valley sewage at Robbins Reef being testified to as existing in the most exaggerated form in the waters immediately surrounding all the shores of the greater city of New York. It can be confidently stated that the complainant's own record in this case establishes beyond question that the City of New York has maintained for many years and is now maintaining a public and private nuisance within the waters of New York Bay, which extends its influence into the waters within the territorial limits of the State of New Jersey. With a little alteration we adopt the language of complainant's brief in this case, found on page 40, and say:

> "This revolting *practice* (scheme) which (contemplates) *inundates* (inundating) the largest industrial population in our country with septic filth, not only menaces with pestilence the health and comfort of our citizens but strikes fatally at the commercial pre-eminence of the greatest port of entry on the American continent."

V.

The Law.

(1) COMPLAINANT IS NOT ENTITLED TO AN INJUNCTION AGAINST THE DEFENDANTS UNDER THE DECISIONS OF THE COURTS, AND IN VIEW OF THE PROOFS AS TO THE CHARACTER OF THE ACTS INTEND-

ED BY THE DEFENDANTS WHICH ARE SOUGHT TO BE ENJOINED.

(2) COMPLAINANT IS NOT ENTITLED TO AN INJUNCTION AGAINST THE DEFENDANTS UNDER THE COMPACT OF 1834, BETWEEN THE STATES OF NEW YORK AND NEW JERSEY.

(3) COMPLAINANT IS NOT ENTITLED TO AN INJUNCTION AGAINST THE DEFENDANTS BECAUSE OF THE CHARACTER OF ITS OWN ADMITTED ACTS IN THE PREMISES.

(4) THE PERMIT ISSUED TO THE DEFENDANT, THE PASSAIC VALLEY SEWERAGE COMMISSIONERS, BY THE UNITED STATES GOVERNMENT IS THE EXERCISE OF A SUPERIOR SOVEREIGN RIGHT, WHICH IS NOT SUBJECT TO ATTACK BY THE COMPLAINANT.

(1) Upon bills to enjoin acts alleged to threaten irremediable damage to complainants, the law requires the following conditions to be shown (*High on Injunctions, Section 742*):

> "Where the injury complained of is not *per se* a nuisance, but may or may not become so according to circumstances, and when it is uncertain, indefinite or contingent, or productive of only possible injury, equity will not interfere."

In Wolcott vs. *Mellick*, 11 *N. J. Eq.*, 204 (213), the Court says:

> "If the nuisance is admitted or if the erection contemplated must from its character

necessarily be a nuisance to the complainant and his legal remedy is not adequate, the Court will enjoin it."

Newark Aqueduct Board vs. *Passaic*, 45 *N. J. Eq.*, 393 (402).

In Morgan vs. *City of Binghamton*, 7 *N. E. Rep.* 124 (Court of Appeals of New York.)

it was held that an injunction should not be granted against the construction of a sewer by a city where the injury complained of is that in the course of two or three years the sewage discharged therefrom into the river may be so increased as to be deposited upon low ground belonging to the petitioner, lying along the river, and so poisoning and infecting the air. Finch, J., says:

"The findings plainly disclose two characteristics of the apprehended danger. It is not imminent and it is wholly contingent and not inevitable. No immediate danger exists. It is found to be possible within one or two years, but not certain to occur sooner than in three years."

In Robb vs. *The Village of La Grange*, 42 *N. E. Rep.*, 77 (Sup. Court of Ill.)

on bill brought by an owner of land to enjoin the construction of a sewer by the village, threatening injury to his land, Craig, J., says:

"The real question in the case, then, is whether the evidence is sufficient to establish a nuisance. If the evidence of the complainant was considered alone it might be regarded as sufficient to sustain the bill, but a large number of witnesses were introduced on behalf of the defendants, who testify there is no smell or

stench arising from the sewer. There is, therefore, so much conflict in the evidence that we are unable to hold the allegations of the bill proven by such clear and satisfactory evidence as is required in a case of this character where a nuisance has not been established by a judgment in an action at law. * * * It will be observed, however, that this bill was brought before the sewer was completed, and at the time of the trial it may not have been in operation long enough to determine fully whether it would result in a nuisance or not. Under such circumstances we think the bill should have been dismissed without prejudice."

In Butler vs. *Rogers*, 9 *N. J. Equity*, 487, it was held that the Court ought not to interfere in cases of nuisance where the injury apprehended is of a character to justify conflicting opinions whether the injury in fact will ever be realized.

In Harrison vs. *Brooks*, 20 *Ga.*, 537, the Court held that injunctions to restrain nuisances will only be granted in cases of absolute necessity, in which the evil to be prevented is not only possible, but certain and inevitable.

In Holton vs. *Doylestown*, 4 *Brewster*, 333 (*Pa.*), it was held that if the injury be doubtful or contingent, or if the matter complained of is not ipso facto a nuisance or will become such in operation, an injunction will not be granted, and it lies upon the plaintiff to establish his case upon satisfactory proof, which does not consist of the opinions of witnesses. To the same effect is *Pfingst* vs. *Senn*, 23 *S. W.*, 358 (*Ky.*).

We submit that the case of *Missouri* vs. *Illinois*, 200 *U. S.* (26 *U. S. Sup. Ct. Rep.* 268) is controlling in this litigation. It is as to matters of law as well

as matters of fact on all fours with the present controversy. The suit in that case was brought by the State of Missouri to restrain the discharge of the sewage of Chicago through an artificial channel into the Des Plaines River in the State of Illinois. That river empties into the Illinois River, and the latter empties into the Mississippi River at a point about forty-three miles above the City of St. Louis, Missouri. It was alleged in the bill that the result of the threatened discharge would be to send fifteen hundred tons of poisonous filth daily into the Mississippi, to deposit great quantities of the same upon the bed of the last-named river belonging to the plaintiff, and so to poison the water of that river, upon which various of the plaintiff's cities, towns and inhabitants depended, as to make it unfit for drinking, agricultural or manufacturing purposes. It is to be noted that the Chicago drainage canal diverts the sewage of the City of Chicago from its natural point of discharge and transfers it into an entirely distinct watershed, discharging it into fresh waters used by the municipalities of Missouri for drinking purposes as well as other uses.

The injunction was denied. Justice Holmes, delivering the opinion, says:

> "Before this court ought to intervene the case should be of serious magnitude, clearly and fully proved, and the principle to be applied should be one which the Court is prepared deliberately to maintain against all considerations on the other side. See *Kans.* vs. *Colo.*, 185 *U. S.*, 125; 46 *L. Ed.*, 838; 22 *Sup. Ct. Rep.*, 552.
>
> "As to the principle to be laid down, the caution necessary is manifest. It is a question of the first magnitude whether the destiny of the

> great rivers is to be the sewers of the cities along their banks, or to be protected against everything which threatens their purity. To decide the whole matter at one blow by an irrevocable fiat would be at least premature."

Applying the principles of law laid down in the cases cited to the proofs in this case, it will be found that no one of the requirements of the cases is made by the proofs in this case. The creation of a nuisance is not admitted, but is in fact denied. The works contemplated will not from their character necessarily be a nuisance to the complainant, but on the contrary, upon the admission of its own witnesses, can be operated so as to produce no nuisance. When there is added the undisputed fact that the stipulation between the United States and defendants in this cause, if carried into effect, as the witnesses for the complainant testify it can in fact be carried into effect, will result in conditions in no way harmful to the complainant, no basis is established for the granting of the injunction prayed for by the complainant.

(2) The location of the proposed outlet in New York Bay is concededly about one-half mile west of the boundary lines between the States of New York and New Jersey. As we shall see, and as is well known to the Court, the settlement of that boundary line was a matter of agreement between the two states in 1833, owing to the fact that there were no means of locating this boundary line. Joint Commissioners were appointed in New York and New Jersey respectively, the latter pursuant to joint resolution approved February 14, 1888, and found in the Pamphlet Laws of New Jersey for that

year on page 552, authorizing the Governor of New Jersey:

> "To appoint three Commissioners with power on the part of the State to meet any authorities of the State of New York, and with them locate and mark out by reference to permanent landmarks, monuments or buoys, the boundary line between the two states in lands under water in the Hudson River, New York Bay, Kill von Kull Sound and Arthur Kill or Staten Island Sound."

Pursuant to this authority it is admitted that the line was fixed as portrayed upon Defendant's Exhibit No. 4, Record, p. 4619. The line is a heavy black line running generally north and south from a point designated on the map as K. or A. A. to J. (Record, p. 2613.)

Inasmuch as the complainant, both in its bill of complaint and its brief, relies upon some alleged peculiar rights that the State of New York claimed by it in the *locus in quo*, it is necessary that we briefly narrate the facts touching this boundary line.

Owing to the descriptions that were contained in the Grants by the Crown to the Provinces now known as New York and New Jersey respectively, disputes arose almost immediately after the organization of the Government of the United States under the present Constitution as to the exact boundary line between the two states. The history of these disputes appears in several of the cases hereafter referred to, notably *Central R. R. Co.* v. *Jersey City*, 70 *N. J. L.*, 81, and *In re Deroe Manufacturing Co. in this Court*, 108 *U. S.*, 401. The differences had become so acute that an original bill was

filed in this Court by the State of New Jersey against the State of New York in 1828, seeking an adjudication. This led to the appointment of Commissioners in both states, pursuant to legislative authority passed therein, who, after full consideration, joined in an agreement or treaty which subsequently received the sanction of the Legislatures of the respective states, and of Congress. See *Laws of New York for* 1834, *chap.* 8, *p.* 8; *Laws of New Jersey for* 1834, *p.* 118; *Act of Congress, June* 28, 1834, 4 *Statutes*, 708.

A copy of this compact is attached to the bill of complaint herein, and for convenience is appended to this brief as "Appendix 4." The significant provisions are Articles First and Third, reading as follows:

> "Article first. The boundary line between the two States of New York and New Jersey, from a point in the middle of Hudson River opposite the point on the west shore thereof, in the forty-first degree of north latitude, as heretofore ascertained and marked, to the main sea, shall be the middle of the said river, of the Bay of New York, of the waters between Staten Island and New Jersey, and of Raritan Bay, to the main sea, except as hereinafter otherwise particularly mentioned.
>
> "Article third. The State of New York shall have and enjoy exclusive jurisdiction of and over all the waters of the Bay of New York, and of and over all the waters of Hudson River lying west of Manhattan Island and to the south of the mouth of Spuyten Duyvel Creek, and of and over the lands covered by the said waters to the low-water mark on the westerly or New Jersey side thereof; subject to the following rights of property and of jurisdiction of the State of New Jersey, that is to say:

(1) The State of New Jersey shall have the exclusive right of property in and to the land under water lying west of the middle of the Bay of New York and west of the middle of that part of the Hudson River which lies between Manhattan Island and New Jersey.

(2) The State of New Jersey shall have the exclusive jurisdiction of and over the wharves, docks and improvements made, and to be made, on the shore of the said State, and of and over all vessels aground on said shore or fastened to any such wharf or dock; except that the said vessels shall be subject to the quarantine or health laws and laws in relation to passengers, of the State of New York, which now exist or which may hereafter be passed.

(3) The State of New Jersey shall have the exclusive right of regulating the fisheries on the westerly side of the middle of the said waters, provided that the navigation be not obstructed or hindered."

This agreement, having received the highest possible sanction, has been construed by the highest courts of both of the contracting states, and by this Court, and any confusion arising from its phraseology has been entirely cleared away by these decisions, to which we shall briefly refer. The earliest of these decisions is *State* v. *Babcock*, 30 *N. J. L.*, 29, decided in 1862, the opinion of which, having been written by Justice Elmer, is entitled to considerable weight, as he was one of the New Jersey Commissioners who negotiated and signed the treaty. There an indictment was found in the New York courts for obstructing the Hudson River by a nuisance west of the boundary line established by the treaty. Justice Elmer, speaking of the treaty, says:

"Although for some purposes, New Jersey is bounded by the middle of the Hudson River, and the State owns the land under the water to that extent, exclusive jurisdiction, not only over the water, but over the land to the low water line on the New Jersey shore, is in plain and unmistakable language, granted to, or rather acknowledged to belong to the State of New York. There is no reason to doubt that the tribunals of that State, which have a common interest in preventing all obstructions to the navigation of the waters surrounding their most important city, will not only punish all crimes against our citizens or their own, while in or upon those waters, but will also adequately punish all interference with the navigation. The case does not materially differ from a line between two states on the land which happens to be the scene of a busy population, where a manufactory near to that line, in one State, may be a nuisance to the citizens of the other, whose redress will have to be obtained from the tribunals of the State in which the nuisance is situate."

He adds:

"When the Commissioners of New Jersey and New York again met, in 1833, and it was found that those of the latter State appeared to be desirous of arranging the dispute upon fair and liberal terms, but deemed it indispensable that their great commercial emporium should have the exclusive control of the police on the surrounding waters, and full power to establish such quarantine regulations as should be found necessary, the Commissioners of this State deemed it wise to secure the exclusive property in the soil to the middle of the river, and exclusive jurisdiction over the wharves, docks and other improvements made or to be made on the Jersey shore, and of the vessels

> fastened thereto and the right to regulate the adjacent fisheries, leaving to New York, which was thought to be quite as much a burthen as a privilege, *the exclusive jurisdiction over the offences* in or upon the waters or the land covered by the water outside of the low water mark."

The question next arose in New York, in the case of *People* v. *Central R. R. Co. of N. J.*, 42 *N. Y.* 283 (1870), where a decision of importance was rendered reversing the lower court.

The action was commenced by the Attorney General of New York, to abate as nuisances certain wharves, piers, and other structures placed by the defendant Railroad Company in the Harbor of New York, and extending into the Hudson River about a mile from the New Jersey shore, all of which structures were confessedly west of the boundary line as established by the treaty. It was claimed by the Attorney General, and by the court below, that the effect of the treaty was to bestow upon New York State the right to entertain jurisdiction of the action, and the lower court directed the removal of the structures and the abatement of the alleged nuisance created thereby. The opinion says:

> "The cause of action set forth in the complaint is clearly one of equitable cognizance; and as the jurisdiction of the Supreme Court is co-extensive with the boundaries of the State, it clearly had jurisdiction of such cause of action, if the place where the nuisances complained of were erected and existed *was within the territorial limits of the State.*"

It then proceeds, after showing that the propriety of the decision below depended upon the agreement or treaty between the States, critically to examine the agreement, and reached the conclusion that the New York courts had no jurisdiction or rights in the premises. The whole opinion is important, but for brevity we quote the following:

> "Whatever doubt may have existed before upon the subject immediately upon the adoption and ratification of this convention or treaty, the sovereignty and jurisdiction of the respective States extended and attached to that portion of the said river and other waters assigned to each State respectively by said article up to the line of the boundary therein fixed and established. * * *
>
> "The right of absolute sovereignty, which includes all the powers of government, all the authority, executive, judicial and legislative, which the several States possess and exercise, subject to the constitutional supremacy of the national government, doubtless belongs to New Jersey, over the domain and territory of said State. This right of governmental control may doubtless be modified by compact between the States. And this brings us to the inquiry, how far, if at all, the State of New Jersey had made a binding provision by treaty for the cession and extinguishment of any of her territorial or governmental rights to the State of New York, over the waters or land referred to in said treaty. * * *
>
> "It is quite apparent, I think, that they well and wisely considered that the necessities of the case, the welfare of these States, the exi-

gencies of the commerce, and the interests of the city and port of New York in particular, in whose prosperity, as the commercial metropolis of the country, New Jersey had, in a large degree, a common interest, required that there should be a unity of control over said waters, and a single and exclusive jurisdiction exercised over them by one of the said States. And this control or jurisdiction, in the language used in that treaty or agreement, was very properly conceded to this State in the following Article:

"Article 3. 'The State of New York shall have and enjoy exclusive jurisdiction of and over all the waters of the Bay of New York, and of and over all the waters of Hudson River lying west of Manhattan Island and to the south of the mouth of Spuyten Duyvil Creek, and of and over the lands covered by said waters to low water mark on the westerly or New Jersey side thereof, subject to the following rights of property and of jurisdiction of the State of New Jersey.' This provision in the treaty most clearly and distinctly gives and grants to and vests in the State of New York, *full, complete and undoubted control, government and jurisdiction* of and over all the waters therein mentioned. Such was the clear intent and purpose of this provision; and, so far as it was essential to the proper exercise of such jurisdiction, it gives a control also of and over the land covered by such waters. It doubtless was designed in the clause of said provision in these words: 'Of and over the lands covered by the said waters to low water mark,' to disembarrass the jurisdiction so conferred over the said water, from all pretense of right to interfere therewith arising from the legal maxim, that the owner of the soil owned all

above it, *cujus est solum est usque ad coelum.*' So that the jurisdiction over the water should be absolute and unquestioned for all practical purposes.

"It clearly could not have been the intention in these words to re-cede to New York what had just been relinquished in respect to the boundary between the two States in the first article or to nullify the force of such article; for it declares expressly that the rights over the water so granted were subject to the rights of property and of jurisdiction of the State of New Jersey, following:

"First. That the State of New Jersey shall have the exclusive right of property in and to the land under the water lying west of the middle of the Bay of New York, and west of the middle of that part of Hudson River which lies between Manhattan Island and New Jersey.

"Second. That the State of New Jersey shall have exclusive jurisdiction of and over the wharves, docks and improvements made and to be made on the shore of said State, and of and over all vessels aground on said shore, or fastened to any such wharf or dock, except that the said vessels shall be subject to the quarantine or health laws in relation to passengers of the State of New York, which now exist or which may hereafter be passed.

"Third. The State of New Jersey shall have the exclusive right of regulating the fisheries on the westerly side of the middle of said waters, provided that the navigation be not obstructed or hindered.

"These provisions clearly show that it was not the intention of New Jersey, in giving

jurisdiction to New York over the waters of such State, to relinquish any of the important rights of property which were acquired by or conceded in the first article of the said treaty. * * *

"It was this very claim and the legal rights and consequences resulting from it, if allowed, which New Jersey had long resisted. This was in legal effect renounced and abandoned by this State in the first article of said treaty; and New Jersey as a sovereign, independent, co-equal state, acquired thereby, if she did not before possess, all the rights of proprietorship in said river and bay west of the center thereof possessed by this State east of the same center line. * * *

"The remaining articles of said agreement, all fairly considered, conduce to the same construction, and confirm the view that *the jurisdiction conferred* upon this State over the waters of said river and bay was a qualified and limited jurisdiction *conferred for police* and *sanitary purposes*, and to promote the *interests of commerce in the use and navigation of said waters, and was not designed to confer or create control* over the lands or domains of New Jersey, or to give to this State any right to interfere with her complete political or governmental jurisdiction as a sovereign State of and over her own soil, and its appurtenances, and of and over every description of property of any appreciable value within her territorial limits."

The result was that the judgment of the lower court was reversed and the complaint ordered to be dismissed.

In *Ferguson* v. *Ross*, 126 *N. Y.* 459 (1891), the Court of Appeals gave unanimous approval to the case of *People* v. *Central R. R. Co.*, *supra*. There an action was commenced by an officer called the Shore Inspector, appointed by the Governor of New York pursuant to express legislative authority in an act to prevent deposits of a certain character in the North or East Rivers, or in the Bay of New York "within the jurisdiction of the State of New York." The deposit in question had admittedly been made by the defendant in the waters of the River on the New Jersey side opposite the City of New York. The court sustained the jurisdiction, saying:

> "By the compact entered into between New York and New Jersey, the particulars of which are set forth in the opinion in that case, the middle of the North River was declared to be the boundary between the two states; but by the third article exclusive jurisdiction of and over all the waters of the Bay of New York and of the Hudson River lying west of Manhattan Island and to the south of Spuyten Duyvil creek, and of and over the lands covered by said waters to low-water mark on the New Jersey side thereof, was ceded to the State of New York, reserving to the State of New Jersey jurisdiction of wharves, docks and piers on the Jersey shore. The purpose of vesting exclusive jurisdiction over these waters, in the State of New York, was *to promote the interests of commerce and navigation*, which would, as supposed, be best subserved by giving to this State the exclusive *control and regulation of the waters of the bay and harbor of New York*."

The subject received comprehensive and intelligent consideration by the New Jersey courts in *Central R. R. of N. J. vs. Jersey City*, 70 *N. J. L.* 81. The opinion of the Supreme Court there reported was affirmed by the Court of Errors and Appeals for the reasons given by Justice Garrison in the Supreme Court. 72 *N. J. Law*, 311. It is difficult to make any satisfactory excerpts from this able opinion, which should be read *in toto*.

Here the Central Railroad Company of New Jersey (the same company that was defendant in the case of *People v. Central R. R. Co.*, 42 *N. Y.* 283, *supra*) sought to escape taxation upon lands owned by it but lying under the waters of the Hudson River in Jersey City, and located, of course, west of the boundary line. The effect of this decision is:

1. The agreement of 1833 between the commissioners representing the States of New Jersey and New York, having been confirmed by the legislature of those states, respectively, and approved by the congress of the United States, established the boundary line between this State and the State of New York in the middle of the Hudson River and of the Bay of New York.

2. The sovereignty of the State of New Jersey is co-extensive with the territorial limits thus established, subject only to such exceptions and to such extra-territorial jurisdiction as was by the said agreement conceded to the State of New York.

3. The word "jurisdiction" is not used in article 3 of this agreement in the sense of sovereignty.

After a full review and consideration of the treaty, as well as the New York decisions referred to, the opinion concludes:

> "From these considerations, the conclusions reached are that the agreement of 1833 between the commissioners representing the states of New Jersey and New York, having been confirmed by their respective legislatures and approved by the congress of the United States, established the boundary line between this State and the State of New York in the middle of the Hudson River and of the Bay of New York, and that the sovereignty of the State of New Jersey is co-extensive with the territorial limits thus established, subject only to such extra-territorial jurisdiction of a *juridical character* as was by the said compact conceded to the State of New York, from which it results that the sovereign power of taxation over all the teritory thus defined resides in the State of New Jersey."

The decision, therefore, sustained the taxability of the lands by the authorities of New Jersey, holding that the sovereign right of taxation undoubtedly existed in that State of the lands lying west of the boundary line. Upon this particular point the opinion says:

> "The question is one of first impression, being entirely distinct from the right to exercise civil or criminal jurisdiction which has hitherto been the only aspect in which the compact has been presented for judicial consideration. With respect to the right last mentioned, namely, that of administering jurisprudence over the territory declared by the compact of

1833 to be within the boundaries of the State of New Jersey, it was held by this court, in the case of *State* v. *Babcock*, 1 *Vroom* 29, that an indictment for a nuisance by placing wrecks in the Hudson River below low water mark on the New Jersey shore would not lie in this State, upon the ground that by the compact in question exclusive jurisdiction over offences in or upon the said waters or the land under them resided in the State of New York. Later, the Court of Appeals of the State of New York, in the case of *People* v. *Central Railroad of New Jersey*, 42 *N. Y.* 283, held that the courts of New York had no jurisdiction to abate by injunction nuisances extending out into the bay or river from the New Jersey shore, upon the ground that by the compact in question the jurisdiction conferred upon New York over the waters of the bay and river was a qualified and limited jurisdiction for *police and sanitary purposes, or to protect the interests of commerce*, and was not designed to give to New York any right to *interfere with the complete political or governmental jurisdiction of New Jersey as a sovereign State over her own soil and its appurtenances*, and of and over every description of property within her territorial limits, which ruling was followed by the same court in 1891, in the case of *Ferguson* v. *Ross*, 126 *N. Y.* 459."

This case was brought by writ of error to this court, and the judgment of the New Jersey courts sustaining the tax was here affirmed. *Central R. R. of N. J.* v. *Jersey City*, 209 *U. S.* 473. The opinion of Mr. Justice Holmes ably and succinctly analyzes the significant portions of the treaty as follows:

"By Article I the boundary line between the two States from a point above the land in dispute is to be the middle of the Hudson River, of the Bay of New York, of the water between Staten Island and New Jersey, etc., 'except as hereinafter otherwise particularly mentioned.' By Article II New York retains its present jurisdiction over Bedlow's and Ellis Islands, and exclusive jurisdiction over certain other islands in the waters mentioned. By Article III New York is to have 'exclusive jurisdiction of and over all the waters of the Bay of New York and of and over all the waters of the Hudson River lying west of Manhattan Island and to the south 'of the above mentioned point,' and of and over the land covered by the said waters to the low water mark on the westerly or New Jersey side thereof, subject to the following rights of property and jurisdiction of the State of New Jersey, that is to say: 1. The State of New Jersey shall have the exclusive right of property in and to the land under water lying west of the middle of the Bay of New York, and west of the middle of that part of the Hudson River which lies between Manhattan Island and New Jersey. 2. New Jersey is to have exclusive jurisdiction over wharves, docks and improvements made or to be made on its shore and over vessels aground or fastened there, subject to the quarantine and passenger laws of New York. 3. New Jersey is to have the exclusive right of regulating the fisheries on the west of the middle of said waters, providing that navigation be not obstructed or hindered."

He adds:

"Thus the land which has been taxed is on

the New Jersey side of the boundary line but under the 'exclusive jurisdiction' of New York, subject to the exclusive right of property in New Jersey and the limited jurisdiction and authority conferred by the paragraphs summed up. The question is which of these provisions governs the right to tax. It appears to us plain on the face of the agreement that the dominant fact is the establishment of the boundary line. The boundary line is the line of sovereignty, and the establishment of it is not satisfied but is contradicted by the suggestion that the agreement simply gives the ownership of the land under water on the New Jersey side to that State as a private owner of land lying within the State of New York. On the contrary, the provision as to exclusive right of property in the compact between States is to be taken primarily to refer to ultimate sovereign rights, in pursuance of the settlement of the territorial limits, which was declared to be one purpose of the agreement, and is not to be confined to the assertion and recognition of a private claim, which, for all that appears, may have been inconsistent with titles already accrued and which would lose significance the moment that New Jersey sold the land. We repeat that boundary means sovereignty, since in modern times sovereignty is mainly territorial, unless a different meaning clearly appears.

It is said that a different meaning does appear in the Article (III) that gives New York exclusive jurisdiction over this land as well as the water above it. But we agree with the state courts that have been called on to construe that part of the agreement that *the purpose was to promote the interests of commerce and navigation, not to take back the sov-*

ereignty that otherwise was the consequence of Article I. This is the view of the New York as well as of the New Jersey court of errors and appeals, and it would be a strange result if this court should be driven to a different conclusion from that reached by both the parties concerned. *Ferguson* v. *Ross*, 126 *N. Y.* 459, 463; *People* v. *Central R. R. Co.*, 42 *N. Y.* 283. This opinion is confirmed by the judgment delivered by one of the commissioners in *State* v. *Babcock*, 1 *Vr.* 29. Again, as was pointed out by the state court, the often expressed purpose of the appointment of the commissioner and of the agreement to settle the territorial limits and jurisdiction must mean by territorial limits sovereignty, and by jurisdiction something less. It is suggested that jurisdiction is used in a broader sense in the second article, and that may be true so far as concerns Bedlow's and Ellis Islands. But the provision there is that New York shall retain its 'present' jurisdiction over them, and would seem on its face simply to be intended to preserve the status quo ante, whatever it may be.

Throughout nearly all the articles of the agreement, other than those in controversy, the word jurisdiction obviously is used in a more limited sense. The word has occurred in other cases where a river was a boundary, and in the Virginia Compact was held to mean, primarily at least, *Jurisdictio* authority to apply the law to the acts of men. *Wedding* v. *Meyler*, 192 *U. S.* 573, 584. Whether in the case at bar some power of police regulation also was conferred upon New York, as held in Ferguson v. Ross, need not be decided now. That New Jersey retained the sovereignty, however, seems to be assumed in Article III

(2) giving her exclusive jurisdiction over wharves, docks and improvements, made and 'to be made' on the shore. This does not grant the right to make such improvements, but assumes it to exist. But the right would need the permission of New York, except on the hypothesis that New Jersey had sovereign power over the place."

The use of tidal waters for the disposal of sewage has been exhaustively discussed and determined to be a sovereign right by the Court of Errors and Appeals of New Jersey.

Sayre vs. Newark, 60 N. J. Equity, 361.

locus in quo.

Taking the conclusion of this court in the above case that the jurisdiction granted to the State of New York by the compact in question was a limited one, the purpose of which was to promote the interests of commerce and navigation as conclusive in this case, we submit that the bill of complaint and the evidence fail to disclose any attempt on the part of New York State to make regulations for the promotion of the interests of commerce and navigation, or any acts on the part of the defendants in violation of such regulations, or injurious to the interests in question.

The provisions of Section 75 of the Public Health Law, annexed to the bill of complaint as "Schedule D," Record, page 23, obviously has no application in this suit, as by its own terms it applies only to the waters of the State of New York. It reads as follows:

"No person, corporation or municipality, shall place or cause to be placed, or discharge

or cause to be discharged *into any of the waters of this State*, unless the same shall have been permitted by the State Commissioner of Health, any sewage, garbage, offal, dead animal, dead fish, dead bird or part thereof, or any decomposable or putrescible matter of any kind or any substance, chemical or otherwise, containing the same in quantities injurious to the public health, or any refuse or waste matter, either solid or liquid, in quantities injurious to the public health, from any shop, factory, mill or industrial establishment; unless express permission to do so shall have been first given in writing by the State Commissioner of Health as provided in this article, except as hereinafter provided."

If any attempt to regulate commerce and navigation had in fact been made by the State of New York applicable to the waters of the Bay of New York, they must of necessity in a Court of Equity be subject to examination as to their reasonableness, fairness and uniformity. It must also appear that the complainant has in fact executed such regulations impartially throughout the waters of the Bay of New York, and does not permit practices to exist within its own sovereignty which it attempts to prevent within the sovereignty of the State of New Jersey under the limited jurisdiction conferred by the compact. That naturally leads to the following considerations:

(3) THE MAXIM THAT "HE WHO COMES INTO A COURT OF EQUITY MUST COME WITH CLEAN HANDS" IS FUNDAMENTAL AND AXIOMATIC, AND WAS APPLIED BY MR. JUSTICE HOLMES IN *MISSOURI* VS.

ILLINOIS, 200 *U. S.* 396, IN THE FOLLOWING LANGUAGE:

> "If we are to judge by what the plaintiff itself permits, the discharge of sewage into the Mississippi by cities and towns is to be expected. We believe that the practice of discharging into the river is general along its banks, except where the levees of Louisiana have led to a different course. The argument for the plaintiff asserts it to be proper within certain limits. These are facts to be considered. Even in cases between individuals, some consideration is given to the practical course of events. In the black country of England parties would not be expected to stand upon extreme rights. *St. Helen's Smelting Co.* vs. *Tipping*, 11 *H. L. Cas.*, 642. *See Boston Ferrule Co.* vs. *Hills*, 159 *Mass.* 147, 150, 20 *L. R. A.* 844, 34 *N. E.* 85. Where, as here, the plaintiff has sovereign powers, and deliberately permits discharges similar to those of which it complains, it not only offers a standard to which the defendant has the right to appeal, but, as some of those discharges are above the intake of St. Louis, it warrants the defendant in demanding the strictest proof that the plaintiff's own conduct does not produce the result, or at least so conduce to it, that courts should not be curious to apportion the blame."

The case at bar discloses in an exaggerated form every feature referred to by the learned justice in the above opinion as precluding any relief to the plaintiff therein. Judged by what New York itself permits, the discharge of sewage into Upper New York Bay is to be expected. Not only is this true of New York Bay, but it is true of all the harbors

in the civilized world, as will appear from an examination of the testimony in this case with relation to various harbors examined by the witnesses.

The complainant in the case at bar has sovereign powers, and deliberately permits discharges more objectionable than those of which it complains, and thereby offers a standard to which the defendants have a right to appeal. It is safe to say that over fifty per cent. of the voluminous record in this case consists of testimony as to the effect of the discharge of sewage by New York City into the waters surrounding it. For illustrations of the character of this testimony we refer the court to the following: Record, Vol. II, pages 1209, 1490, 1510, 1551, 1620, 1672, 1687 et seq.; Record, Vol. III, page 2007.

The effect of the sewage discharged by the City of New York into the Upper Bay on fish, Record, Vol. I, 459-460; on shell fish, Record, Vol. III, page 1969; on bathing, Record, Vol. III, page 2290.

The evidence referred to will disclose conditions created by the City of New York of the same kind, but to a greater degree, than is charged in the bill of complaint, as likely to result from the acts of the defendants; and if the sewage of the Passaic Valley were in fact to be discharged into New York Bay near Robbins Reef, without treatment of any kind, the result, excepting possibly at the immediate point of discharge, would not be perceptible in any way within the limits of the State of New York; and it is very doubtful whether the effects at the immediate point of discharge would extend beyond the territorial limits of the State of New Jersey.

V. Reply to Brief for Complainants.

Statement of Fact.

Disregarding the number of incidental mistakes in the alleged statement of fact, such as, for example, the number of municipalities in the Passaic Valley District, which is twenty instead of thirty-six, and the law under which the Passaic Valley Sewerage Commission was constituted a corporation was 1903 instead of 1907, there are two matters of considerable importance the correction of which is necessary to prevent misunderstanding on the part of the court.

The first is that "in January, 1909, *and after the granting of the permit by the Federal Government*, the Department of Justice, on behalf of the United States Government, moved for permission to intervene as complainant in the suit now before the court." The chronology of the proceedings at the beginning of this brief will indicate that the intervention by the United States was by order made on January 4, 1909. No permit was executed until after the filing of the stipulation between the United States and the defendants, which appears as "exhibit No. 135 for the complainants" (a copy of which is appended to this brief). Reference to this stipulation will show that it was approved on behalf of the State of New Jersey on April 14, 1910. The permit itself will be found immediately following page 4619 of the record, volume V; defendants' exhibits 6 and 7, September 22, 1911.

It is accordingly not a fact that the intervention by the United States was after the granting of the permit by the Federal Government.

The statement in the brief immediately following

that above criticized, viz: "The motion of intervention was granted on the ample presentation by the Department of Justice of the unsatisfactory conditions incident to the issuance of the trunk sewer permit," is also unfounded and might create a misunderstanding of the situation.

It is possible that complainants' counsel have confused the application of the City of New York for leave to intervene in this suit, as attempted under date of December 12, 1910, denied by this court under date of December 19, 1910, which motion was made after the execution of the stipulation, but before the actual issuance of the permit.

The inference which might be drawn from the misstatement in complainants' brief is that the Department of Justice was in fact dissatisfied with the terms upon which the permit was granted, the fact being that the stipulation provided that no permit should be granted except upon the terms of the stipulation, and that the Department of Justice was entirely satisfied and withdrew its petition of intervention in this cause.

The second material misstatement of fact appears in a number of versions, a typical one being found on the sixth page of the brief as follows:

> "The Passaic Valley Sewerage project contemplates the operation and maintenance of a mammoth trunk sewer of over twenty-six miles in length, designed to transport the organic filth and trade refuse from thirty-seven municipalities and townships in the Passaic Valley watershed. It is proposed to discharge this putrescent menace at the rate of over 360 millions of gallons per day into Upper New York Bay."

This statement involves one of the important issues in the cause, and is not supported by the testimony of any of the witnesses, either for complainants or the defendants.

I. COMPLAINANTS' COUNSEL SAYS "QUARANTINE LAWS ARE ESTABLISHED FOR THE PROTECTION AND PROMOTION OF THE PUBLIC HEALTH."

This statement is not subject to dispute, but inasmuch as no quarantine laws are involved in this controversy, none being alleged in the pleadings or shown by the evidence, it may, therefore, be disregarded. The discussion of the effect of the compact, ratified in 1834 between the States of New York and New Jersey, has already been anticipated and fully met in this brief. All of the cases cited in the complainants' brief are cited more fully and discussed at length in this brief.

II. THE QUOTATIONS FROM THE TESTIMONY INCLUDED UNDER POINT I, AS WELL AS POINTS II AND III, MAY PROPERLY BE CONSIDERED TOGETHER.

It will be found upon an examination of the quotations of evidence which follow in this brief that all of the witnesses whose testimony is quoted from in complainants' brief have assumed in their direct evidence that the terms of the stipulation between the United States and the State of New Jersey and the Passaic Valley Sewerage Commissioners would not be complied with by the defendants herein, and that their testimony is, in fact, upon direct examination confined entirely to

opinion evidence based upon an assumption that nothing more than the processes and devices prescribed in detail in the stipulation would be done to purify the Passaic Valley sewage so as to produce an effluent which would result as guaranteed in the stipulation. An examination of the testimony of these witnesses on cross-examination will disclose the fact that every one of them admitted that processes could be applied to the Passaic Valley sewage which would result in an effluent of a character to produce the results guaranteed in the stipulation, and that if the guaranteed results were in fact produced no injury of any kind would result to the water of the Upper Bay.

While it would be desirable to quote substantially the whole of the cross examination of the witnesses for the complainants, whose testimony is referred to in complainants' brief, it would result in making this brief too voluminous, and we, therefore, content ourselves with extracts only.

It is to be noted that the witnesses in question are practically all of the expert witnesses produced and sworn on behalf of the complainants. Taking them in order we submit the following citations from the testimony:

Professor William T. Sedgwick, Vol. III, p. 2269, fol. 3297:

> Q. Now, I ask you again that if the effluent discharged into New York Bay produces the guaranteed results, do you mean to say that you think there will be any injury to the property of the United States in the harbor of New York?

A. No, logically speaking. Paragraph 6 seems to cover all that point.

Q. That seems to exclude the injuries which you testified to?

A. But I do not believe that the *means proposed* will produce the results guaranteed.

Q. Well, by that you refer to the sedimentation and screening processes?

A. Yes.

Q. And you do not have in mind any requisite additional arrangements?

A. I do not understand.

Q. I say have you in mind the agreement on the part of the Passaic Valley Sewerage Commissioners to adopt other requisite lawful additional arrangements?

A. I have noted that provision and I have no doubt that additional arrangements could be made which would do away with all my sanitary objections. Whether these would be lawful or not, I am unable to state.

Professor Earl B. Phelps, Vol. 2, page 1638, fol. 2424:

Q. Now, Prof. Phelps, assuming that the legal intent of the instrument is that the Passaic Valley Sewerage Commissioners agree to produce the results in the effluent which are specified in the stipulations, either through the methods and appliances specifically described in the instrument, or stipulations, or by adopting other methods or appliances or devices for purification of the sewage, then do you say that the discharge contemplated will be injurious to the waters of New York Bay?

A. If they discharge an effluent which comes up to the stipulations I believe that effluent will be unobjectionable in the waters of New York Bay.

Page 1639. In answer to a question interjected by counsel for complainants as follows:

"Is it feasible to discharge such an effluent in your opinion?"

The following answer was given:

"I think not."

Q. Why not?

A. Because the cost of producing such an effluent adds to the cost of the sewer so much that it would disrupt the organization. Local purification would be adopted in preference.

Q. Is the effluent more exacting in character than what should be required for the discharge into the fresh streams on which these municipalities, or some of them, are located?

A. Yes.

Q. Than should be required of an effluent into the Passaic River?

A. I will not say into the Passaic River. You said some of the streams. Many of the smaller towns could satisfy the requirements with less exacting specifications than these.

Page 1638, fol. 2423. The following question was asked this witness:

Q. That is your opinion, that that (the necessary effluent) will not flow from the

works constructed in compliance with the requirements of paragraph 1?

A. Yes, sir.

Q. Is it your opinion that it will not flow from other requisite lawful additional arrangements?

A. I do not know anything about that kind of arrangement for sewage treatment.

Q. You do not know of any other devices or methods which can be applied practically toward producing the effluent that is described, with the exception of those contained in paragraph 1?

A. I do not know what would be lawful under those circumstances, for instance.

Mr. Desmond Fitzgerald, Vol. II, p. 1579, fol. 2342:

"The contemplated discharge which I had in mind was the discharge which would be likely to come through a tunnel of the size and position which was described as forming the scheme of the Passaic Valley Sewerage Commissioners, and connected, as they have described, with the different towns and cities along the Passaic Valley."

Page 1580:

"That plan is to collect the sewage from the towns and cities, and the boroughs in the Passaic Valley in an intercepting sewer which shall extend to Newark Bay and there tunnel under Newark Bay and under the City of Bayonne, and under the harbor of New York, the Upper Bay, and discharge as described by the engineer who designed that scheme into the Upper Bay waters."

Page 1581, fol. 2334:

Q. Now, Mr. Fitzgerald, I am evidently up against some misunderstanding of language. I do not clearly express myself. Do you mean to say that through the adoption of additional arrangements to those specified in this contract or stipulation that the results stipulated by the State of New Jersey and the Passaic Valley Sewerage Commissioners cannot be produced in the Bay of New York?

A. I think that is true, but at the same time I am bound to tell you that that is not the language of the stipulation.

Page 1583:

Q. Then you did not take that as the description of the contemplated discharge of this sewer into the waters of New York Bay?

A. Certainly not.

Page 1584:

Q. Do you mean to say that there are no efficient additional arrangements recognized in engineering science beyond those named in this stipulation which will tend to produce the results stipulated for?

A. I do nothing of the kind.

Page 1595:

Q. Now, from what feature of the discharge, as it is described in the stipulation between the United States and the State of New Jersey and the Passaic Valley Sewerage Commissioners, do you attribute the establishment of such a nuisance in New York Harbor?

A. The stipulation which allows them to discharge the sewage of Robbins Reef without any other purification than that incident to the subsidence of one hour.

Page 1596:

Q. That is not what the discharge is defined to be in this instrument?

A. No.

Q. And you say that kind of a discharge, in your opinion, will constitute a nuisance?

A. *That, taken in connection with the rest of the document.*

Professor Charles Edward Amory Winslow, Vol. II, p. 1665, fol. 2463:

"If the stipulations in regard to the absence of visible suspended particles and the absence of odors due to putrescibility, and the absence of grease or color, absence of any damage to health, or the creation of any public or private nuisance, if they were fulfilled in regard to the sewage of New York there could, obviously, be no objection to that discharge, except in regard to the possibility of sludge deposits and injury to fish life."

Page 1668, fol. 2467:

Q. Assuming that the stipulation as to the reduction of the dissolved oxygen in the seventh item of this stipulation as to results means that the oxygen will not be reduced by this discharge in the waters of the bay below a point of 70 per cent. in saturation, do you think that the discharge will be objectionable or injurious to the waters of New York Bay?

A. No, I should say not.

Page 1669, fol. 2468:

Q. Why did you say the cost of living up to those stipulations would be enormous?

A. Because I am familiar with the general cost of sewage disposal plants, and the only kind of plant that could produce results in accord with the literal meaning of these stipulations as to results would be intermittent sand filters, and they would be very expensive.

Page 1671, fol. 2470:

Q. If New York was not discharging its sewage as it is now—which, I think, you say you have observed?

A. Yes.

Q. But was adopting, employing methods of purification comparable to those that are specified in the stipulations which I have been asking about, do you think there would be any real injury by the reduction of the oxygen in the waters of the Upper Bay from the discharge of sewage from the Passaic Sewer?

A. Referring now to the stipulations as to results?

Q. Yes.

A. No, I do not think there would.

Dr. Emil Kuichling, Vol. III, p. 1846, fol. 2708:

Q. Well, Mr. Kuichling, assume that the additional lawful means are such additional means as may be necessary to produce this effluent.

A. In that case there would be a much greater reduction of nuisance or trouble of any kind than I have mentioned.

Q. And you have interpreted them (the stipulations), have you not, as being practically filtered water?

A. A cursory reading gives one the impression that that is what is meant and called for, filtered water. A closer reading, in connection with the other features in the case, leads me to believe that considerably less will be required than filtered water.

Page 1848, fol. 2712:

Q. So that you do not know of any practical method that will relieve the Passaic River and the Newark Bay from its extreme pollution, except by the production of an effluent?

A. I want to qualify that by saying that the betterment of the Passaic River can be obtained by treating the sewage of each community in such manner as to produce an effluent that will not add polluting matter beyond the capacity of the stream to assimilate and absorb.

Q. And that effluent which you have described, is it of a more stringent character than that which is stipulated for in the stipulation which is in evidence in this case?

A. I should make much less stringent stipulations.

Page 1849, fol. 2713:

Q. Well, now, the effluent from this one city, Newark, that you have tentatively located, where would you discharge that?

A. The ultimate effluent would go into Newark Bay.

Q. And you had no question about that effluent not creating a nuisance in Newark Bay?

A. I believe that it would create no nuisance in Newark Bay.

Q. And would it be of a character as stringent as that specified in this stipulation?

A. It would be somewhat less stringent in some respects, but it would call for other means of treatment than are named in this instrument.

Q. Would it be more stringent than that?

A. I do not believe I would make it quite as stringent as that.

Professor Olin H. Landreth, Vol. III, p. 2095, fol. 3040:

Q. I did not ask you about the sewage. I asked you about the discharge. That is what I am asking you about, and that is what you were asked about on the direct. That is what I am asking you for now?

A. I understood your question to speak of the discharge of sewage. Then I will correct my last assumptions by saying I did assume that this plant as proposed would be operated. Would be built and operated.

Q. Now, when you say "this plant," what do you mean?

A. A plant at least equal to that which is indicated in the specifications.

Q. What is that?

A. That is a combined plant for screening and for sedimentation.

Page 2097, fol. 3403:

Q. Well, as to the visible suspended particles coming from the Passaic Valley sewage, do you assume that there will be absence of them in New York Bay or do you assume that there will not be?

A. I assume that there will not be an absence of visible suspended matter.

Fol. 3044:

Q. And do you think it is possible to produce an effluent of the character described in this stipulation, being complainants' Exhibit No. 135?

A. I think it is possible to obtain an effluent under that stipulation, but not necessarily with the plant, which is there described. I do not attach very great importance to that plant, because that is only a suggestion. If that plant does not accomplish the result, you promise to accomplish it in some other way. My objection is that there is no way of finding out whether you have accomplished it or not. You could not yourself find out, I do not believe.

Page 2098:

Q. I want to know whether it is possible for them to produce it (the result)?

A. Certainly it is possible to produce it, but it is not possible to determine whether it is produced or not in those terms themselves.

Dr. Theodore Horton, Vol. 3, p. 2306, fol. 3353:

"My opinion is that if the sewage of these boroughs in the City of New York were treated

in such a way as to produce an effluent such as would meet the stipulations guaranteed, that the City of New York—will you repeat the question again?"

A. I think the sewage would be sufficiently treated to prevent largely a nuisance, and would be substantially free from a menace of health.

Q. And you think the same results produced in the proposed discharge from the Passaic Valley Sewer will create a nuisance in the harbor, do you?

A. No, sir. I will have to go back to that question relative to the specified sewage treatment and the guaranteed results. I have just pointed out that the sewage works will not accomplish the guaranteed results.

Fol. 3356:

Q. Can an effluent in your judgment be produced from the sewage of the Passaic Valley which will, when discharged in New York Harbor, produce the guaranteed results as they are stated in the stipulation?

A. May I refer to the stipulation?

Q. Yes.

A. Yes, sir.

Fol. 3357:

Q. It is your opinion that the specific processes which are defined in the stipulation will not produce the effluent guaranteed?

A. Substantially I so say.

Q. Now, if you add some of the processes which you have testified to, as an alternative, will the guaranteed effluent be produced, in your opinion?

A. Substantially.

Page 2307, fol. 3358:

"Assuming that the intent of the Passaic Valley Sewerage Commissioners and the Secretary of War or the Government, in this case, is to carry out the guaranteed results, I think there will be very little nuisance and very little menace to health."

Dr. Robert Spurr Weston, Vol. III, p. 1986, fol. 2891:

Q. Very well, I ask you about the effluent. I am not asking about the devices. I am asking you whether you are assuming an effluent such as is described in this stipulation in the testimony which you have given in this case?

A. I am not assuming an effluent like that described in the paragraphs which I have just mentioned.

Q. Please assume such an effluent and state what in your opinion will be the result upon the various industries and specifications which you have testified to?

A. It will be discharged without any danger.

Page 1989, fol. 2895:

Q. Well now, it being in your opinion impossible to produce by the appliances, devices and processes described in the stipulation, do you think that through additional arrangements it might be produced?

A. It might be produced by suitable arrangements.

Professor William P. Mason, Vol. III, p. 2993, fol. 3038:

Q. Now, you have given some testimony based upon exhibit No. 135 in connection with the proposed discharge of the Passaic Valley Sewer at Robbins Reef?

A. Yes, sir.

Q. And in giving that testimony you have assumed some character of discharge from the sewer, have you not?

A. Yes.

Q. What is the character that you have assumed?

A. I have assumed that the sewage has the age which it must necessarily have after flowing the distance which it is expected to flow.

Professor Edward Ellery, Vol. III, p. 2933, fol. 2955:

Q. Well, as to the stipulation about which you have been asked to testify in the hypothetical question, did not you say you had examined it?

A. I think that I said that I had examined it. I have looked it over, but I am not competent to testify as to it. I am not a sanitary engineer.

Q. Can you say that you can testify as to the character of the effluent which will be discharged from that sewage project?

A. I can only testify as to the character of any sewage without treatment, as to the effect of any sewage on water, if the sewage is dumped into the water without treatment, or as to the effect of the sewage upon the water,

if I know the character of the effluent. What I have testified to here—I think I am correct in saying it—is that without treatment this sewage would have such and such an effect, and I think I also answered the question of Dr. O'Sullivan, as to what I mean by treatment.

Page 2034, fol. 2956:

Q. Did you assume treatment, or did you not?

A. I do not know that I assumed anything about treatment.

Q. Is it not necessary to assume something about it, in order to testify as to the character of the effluent?

A. Yes.

Q. Then how did you happen to testify at all?

A. I assumed that there would be organic material in the sewage.

Q. Why did you assume it; what was your assumption based on?

A. There is only one part of that stipulation that I think I based that assumption on, and that is that there might remain in the sewage some organic matter that would be invisible, and that would have the effect of depleting the oxygen in the water.

Q. Can you state whether there will be in this effluent enough organic material to produce a nuisance in New York Bay, from anything that you know about the stipulation?

A. Absolutely no.

Dr. Daniel D. Jackson, Vol. III, p. 2176, fol. 3152:

Q. I ask you whether in the effluent which you have in contemplation as coming from the Passaic Valley Sewer, whether you contemplate any other processes will be applied than those that you have testified to in the way of screening and sedimentation?

A. I think not.

Q. There are other processes, are there not, which are applicable to sewage and which produce a more perfect effluent than sedimentation and screening?

A. There are, yes.

Page 2180, fol. 3157:

Q. I ask you whether there can be an effluent produced by treatment of the Passaic Valley Sewage, by which an effluent will be produced which will comply with the stipulations as to the results guaranteed?

A. There can be, yes.

Q. Now, why do you assume that it will not be—why do you assume that such an effluent will not be produced as will produce the guaranteed results?

A. An effluent of that character would require something similar to that which is installed in Baltimore, being installed at the present time so far as I know.

Q. I read from this exhibit the following words: "Second. The Passaic Valley Sewerage Commissioners further agree with the United States that in the operation of said sewer system at all times the following results will be secured either through compliance with the requirements of the immediately preceding paragraphs or through requisite lawful additional arrangements." Have you that

part of the stipulation contained in exhibit No. 135 in mind?

A. I have not, no.

Q. You see it before you as part of the stipulation?

A. I have not heard of it being discussed, that such an extensive plant was contemplated.

Q. And that is the reason why you conclude that that effluent will not in fact be produced, is it, because you have not heard that any such plant was contemplated as will be necessary to produce the effluent?

A. It is.

Harrison P. Eddy, Vol. II, p. 1504, fol. 2228:

Q. In your opinion, is it practicable to adopt arrangements which will produce an effluent of the kind that I have described?

A. I think there are means which would produce an effluent which, if discharged into the bay, would comply with these first four specifications, which I think you read.

Q. Do you intend that in connection with the point of the proposed discharge and the depth of the discharge?

A. That is what I take into consideration, yes, sir.

Q. Do you think it is practicable to produce that result?

A. I do.

Q. Now, when you say that you have taken in consideration the proposal that is embodied in this stipulation, have you in fact taken into consideration the part of the second general paragraph which provides that the Passaic

Valley Sewerage Commissioners agree with the United States that in the operation of said sewer system at all times the following results shall be secured, either through compliance with the requirements of the immediate preceding paragraphs, or through other required lawful additional arrangements? Have you taken into consideration the last clause that I have just read?

A. I have considered it, but I have not based my answer on any works other than those stipulated in this agreement.

Q. Did you exclude from your mind as part of the proposal of the Passaic Valley Sewerage Commissioners the adoption of any arrangements which would produce the effluent required, if the specified arrangements do not produce that result?

A. To the extent that I have based my answers upon the specified works.

Mr. John P. Fox, Vol. II, 1223, fol. 1855:

"The results can be reached, if the Passaic Valley Sewerage Commissioners wish to reach them and take the proper means to do it."

"I was merely trying to point out that the proposed treatment of the sewage as required in the stipulation would not produce the results which are also required in the stipulation."

Q. You do not intend to be understood as testifying that it is impossible to produce these results in the discharge from the Passaic Valley Sewer?

A. No, sir, I have no reason to say that it is impossible under certain conditions.

Mr. John W. Alvord, Vol. III, p. 1896, fol. 2777:

Q. Now, Mr. Alvord, is or is it not possible to add other processes and other means and appliances to those specified in the stipulation which will produce an effluent of a character to produce the results stipulated for in this agreement?

A. Yes; theoretically, I believe it is.

Page 1898, fol. 2779:

"I said that I thought the stipulation, owing to the fact that it calls for an almost perfect effluent except as to various impurities capable of absorbing some dissolved oxygen, makes the stipulation, in my opinion, impracticable."

Page 1900, fol. 2782:

Q. You mean that an effluent cannot be produced which will be of the character described?

A. Cannot be produced by the means described.

Mr. James J. Powers, Vol. III, p. 2646, fol. 3907:

Q. Now, Mr. Powers, assuming that the effluent produced and discharged by the Passaic Valley Sewer System is of the character which is specified in the second general paragraph of complainants' exhibit No. 135, are you still of the opinion that there will be a nuisance created in New York Bay by the discharge of that sewage?

A. There will be no objection.

Page 2647:

Q. Well, now, isn't it possible to produce such an effluent?

A. Yes, sir.

Q. It could be done in a number of different ways?

A. Yes.

Q. And then the effluent in your judgment could be safely discharged into Newark Bay?

A. Yes, sir, or into New York Bay.

Q. Well, you would not advocate the continuous discharge of the sewer into the Passaic River, would you; you would not recommend that?

A. No, sir.

Q. Nor in its crude state into Newark Bay, you would not recommend that?

A. No, sir.

Q. Well, what would you do with it, then?

A. I would purify it so that there would be no objection to its discharge in either one.

Q. Without regard to expense?

A. Without regard to expense.

Q. Then if those guaranteed results are obtained in either of those ways, in your judgment there will be no nuisance in New York Bay?

A. No, sir, not if that was complied with.

Page 2648:

Q. Drawing your attention, Mr. Powers, to the latter sentence that has just been read to you (reading) "or other requisite, lawful ad-

ditional arrangement," what do you understand by that?

A. I would understand from that that any further treatment required would have to be made regardless of the expense.

Mr. James H. Fuertes, Vol. III, p. 1728, fol. 2551:

"You mean, as I understand that, in case the effluent from the Passaic Valley Sewer were to be of the quality stipulated for the discharge from the Montclair, Orange and East Orange sewer, but discharged at a greater depth, at many places under the harbor, as is specified here, then what would be my answer to the hypothetical question."

A. Yes.

Q. Bearing in mind that you said that that effluent as stipulated did not differ materially from the one that is stipulated for and described in this stipulation?

A. Yes, I think in that case there would be practically very little damage done.

Q. The question is, is the discharge of the effluent as described in the stipulation—

A. The quality described here?

Q. Yes.

A. I think there would be no objection to it, if you could produce an effluent like that.

Page 1742, fol. 2569:

Q. Do you have any question that it is possible to produce that effluent by additional devices and processes to those specifically described in the stipulation?

A. It is a physical possibility, certainly.

Q. You contemplated that for Orange, Montclair and East Orange?

A. Yes, sir, but different methods from what are stipulated here.

Q. So that there is no physical impossibility at least of producing the effluent that is described in the stipulation?

A. It can be done.

Dr. Walter Bensel, Vol. III, p. 2288, fol. 3327:

Q. And do you contemplate any treatment of this sewage before it is discharged?

A. I have already understood that it is to be treated by screening and sedimentation without chemical action.

Q. That is your understanding?

A. That is my understanding, yes.

Page 2289, fol. 3328:

Q. Have you a knowledge of whether or not an effluent can be produced that will not cause a nuisance?

A. I know it can be.

Mr. A. Foster Higgins, Captain Charles B. Parsons, Messrs. F. B. Dalzell, Arthur Sanford, Azel F. Merrell, R. A. C. Smith and Henry R. Towne, quoted in complainants' brief, are all laymen, do not profess to be experts in the matter of sewage disposal, and their testimony, therefore, is of no more value than that of any other equally intelligent layman.

Mr. J. William Griffin is quoted on page 24 of complainants' brief as giving an "illuminating answer," which is in effect that it is possible to produce an effluent from the sewage of the Passaic Valley which will not cause a nuisance when discharged into New York Bay, and to that extent seems to be in complete accord with the other witnesses for the complainant above quoted.

We submit that the necessary conclusion from the evidence of the expert witnesses for the complainants is as follows: That not only will no intolerable public or private nuisance be created by the discharge from the proposed Passaic Valley sewer, but, on the contrary, the discharge as proposed and required by the stipulation with the United States Government excludes the possibility of the creation of any nuisance, public or private, and provides that no commercial or property interests can be impaired in any way by the said proposed operation of the Passaic Valley Sewer.

III. UNDER POINT IV. OF HIS BRIEF COMPLAINANT'S COUNSEL SAYS "SANITARY SCIENCE CAN ABATE THE NUISANCE FROM THE PASSAIC VALLEY WITHOUT AFFLICTING A NEIGHBORING COMMUNITY."

This statement assumes the identical false premise involved in points II. and III. of his brief, and discussed above. The obvious answer is that there is no evidence to justify the assumption that the operation of the Passaic Valley Sewer as designed will in fact tend to afflict any neighboring community. Under this point, however, counsel has injected into his brief a suggestion that the State of

New York has tendered to the State of New Jersey a co-operative plan of sewage disposal for the Metropolitan District, including the Passaic Valley, which would relieve the Passaic River from its pollution without discharging an effluent into New York Bay. The only justification for this suggestion is that the State of New York has consistently, since the year 1903, endeavored to exclude the State of New Jersey from using the waters of the Upper Bay as a discharge point for the effluent of the treated sewage from the Passaic Valley, and that the supposed co-operation offered is limited to a visionary suggestion for an ocean discharge and disposal of the sewage of the Passaic Valley, as well as the sewage of the City of New York. The New York Statute of May 11, 1903, Record, Vol. 1, page 368, contains the following section:

> "Section 2. Such commission shall confer with the authorities of the State of New Jersey, take the testimony of witnesses if necessary, and otherwise make such investigation as it may deem advisable to determine the character of such threatened pollution, if any, and *the means necessary to effectually prevent the same* in order to protect the health of the people of this State."

That was the act providing for the appointment of the New York Bay Pollution Commission. The report of this commission to the Governor of New York is set out in the Record, Vol. 1, page 383. This report recommends:

> "In the event of the State of New Jersey pressing the construction of the proposed Passaic Valley sewer plan, the Commission recom-

mends, first, that the Attorney General of the State of New York be authorized and directed to bring action in the Supreme Court of the United States against the State of New Jersey; and this further recommendation, that the Metropolitan Sewerage District Commission should, when appointed, make preliminary surveys for an estimate of cost of a comprehensive system for ocean disposal of sewage for the whole or the greater portion of the Districts in both New York and New Jersey which are naturally tributary to New York Bay and adjacent waters."

The above provisions taken in connection with the institution of the present litigation and its continuance after the stipulation made with the United States Government we submit demonstrates the truth of the charge that the purpose of the State of New York from the outset to the present time has been and is to exclude the State of New Jersey and the Passaic Valley Sewerage Commissioners from utilizing any part of the sewage disposal capacity of the waters of Upper New York Bay.

How illusory, not to say insincere, the proposal for ocean disposal is will be demonstrated by reference to the testimony of complainant's witness, Olin H. Landreth, Record, Vol. 1, page 417, who was asked:

"Q. Did you make any estimate of the cost of ocean disposal such as you have recommended?

A. Except in very general amounts and cases.

Q. How far did you conclude such tunnels would need to extend?

A. Well, a definite distance was not

reached, but we reached the idea that it probably would not be inside of five miles from the bar. When I said the Bar I should have said the Narrows, because we had in mind not so much the Bar itself as the gateway into Upper New York Bay."

Page 418:

"Q. Isn't that subject to all the criticism and more that you are making on the proposal of the New Jersey Sewage Commission?

A. It is certainly open to the criticism of uncertainty, because we made no careful surveys and estimates of the cost, inasmuch as we were not able to make them.

Q. Now, will you state what your estimate of the cost of such a tunnel would be?

A. I do not carry it in mind at all, I simply carry in mind the fact that we concluded that the tunnel method of ocean disposal would be the most reasonable.

Q. Was it less than one hundred million dollars?

A. Well, I cannot attempt to be even as explicit as that.

Q. Was it less than two hundred million dollars?

A. I think I answered that—I think—

Q. What?

A. I think I answered that.

Q. You have answered as to one hundred million dollars. Now I ask if it was less than two hundred million dollars?

A. I cannot undertake to give the measure of cost.

Q. Can you give it within no limits at all?

A. If I fix a limit I should be misrepresenting my own condition of mind even then, and much more so now.

Q. Would you say it was less than one thousand million dollars?

A. I do not think it is worth while to talk about those figures, too speculative.

Q. I ask you if you did not form an estimate of the probable cost of it?

A. At that time we did form an estimate of the probable cost.

Q. What was it?

A. I do not recall. I do recall that the burden of cost estimated was less than it was for the then estimated cost of separate disposal work."

The truth is that the only improvement in the method of the discharge of the sewage of New York City in serious contemplation is by the application to it of screening and sedimentation to a much less degree than is provided for in the stipulation between the United States and the State of New Jersey. This is clearly indicated by the testimony of complainant's witness, Daniel D. Jackson, Record, Vol. III, page 2174:

"Q. You have testified to plans for screening and sedimentation that are now under consideration. What are those plans?

A. I have not testified to any plans.

Q. Do you know what they are?

A. Do you refer to the sewer department or do you refer—

Q. I refer to your testimony. I refer to the fact that you testified that there is under consideration for the City of New York screening

and sedimentation processes which are being compared as to cost with the dilution of the ocean.

A. That is being done by the Department of Sewers.

Q. Do you know anything about them?

A. Only in a general way.

Q. And do you know how much sedimentation is contemplated in those plans?

A. It is being considered from different points of time, depending upon the results obtained on the sewage itself. It has been found that most of the sedimentation occurs within one hour and the plans would probably be designed along those lines.

Q. But you do not know what the plans are that are being considered?

A. The plans are for sedimentation and screening."

The motive of the State of New York and the City of New York in attempting to exclude the State of New Jersey and the Passaic Valley Sewerage Commissioners from participation in the sewage disposal capacity of Upper New York Bay is not the fear of the results directly attributable to the New Jersey sewage, but the fear of the consequences of New York's own acts, which threaten the establishment of serious nuisances in and about the waters adjoining the City of New York through the exhaustion by the City of New York of the disposal capacity of those waters.

Professor Phelps, one of complainant's witnesses, testified, Record, Vol. II, page 1620, as follows:

"Q. As a matter of fact, the sewage of the greater City of New York is from your point

of view discharged in the most objectionable way possible, is it not?

A. Yes.

Q. And the waters in the area which you have arbitrarily described by letters, but which I think you have described as being included within the mouth of the Hudson or some point upon the Hudson River, are in your judgment polluted to a dangerous extent?

A. They are.

Q. And in what does that danger consist?

A. They have reached a condition measured by the dissolved oxygen where there are unsightly appearances and odors found to follow."

Mr. Powers, another witness of complainant, Record, Vol. III, page 2643, testifies, in answer to the question:

"Q. What adjectives would you use for the discharge of crude sewage by the City of New York directly into the waters of New York Bay?

A. It is perfectly inexcusable in this age."

It is hardly necessary to refer to testimony to establish the fact that the sewage of the City of New York is increasing in amount. There will be found in the record, Vol. III, page 2289, a statement to that effect by one of complainant's witnesses. More significant, however, is the statement of Dr. Weston, another of complainant's witnesses, Record, Vol. III, page 958, folio 2857, et seq., that the growth of population in the Metropolitan District can be estimated at twenty-five per cent. every

ten years at least, and that the increase of sewage corresponds with the increase in population.

The necessity for the City of New York taking steps in the future to purify its sewage is testified to by Mr. Alvord, Record, Vol. III, page 1891:

> "I believe that it will be inevitable that the City of New York will have to in the future take steps to largely purify its sewage."
>
> Q. Those steps will be in your opinion the establishment of local purifying plants for treating the fresh sewage?
>
> A. Very largely.

Page 1893:

> Q. Does the discharge, as you have observed it, from the sewers of the greater City of New York create a nuisance in the waters of the Bay?
>
> A. Yes, sir, I believe that is true, and I am certainly of the opinion that the City of New York should proceed to abate that nuisance as rapidly and as quickly as a consistent, careful study of that problem will allow.

His testimony immediately following indicates exactly how much or how little the City of New York has in fact done since 1903.

Taking the facts as they are disclosed by the evidence, it is fair to say that the real motive of the State of New York in this litigation is to attempt to monopolize for the City of New York the sewage disposal capacity of the waters of Upper New York Bay. This motive is avowed by some of complainant's expert witnesses without disguise.

For example, Mr. Fitzgerald, Record, Vol. II, page 1574, says, in answer to the question:

> "Now, Mr. Fitzgerald, will you tell me if you can what proportion of the sewage digestive capacity of the waters of the Bay of New York will be used in the caring for of the sewage of a population of 750,000 inhabitants, discharged at Robbins Reef through the projected Passaic Valley Sewer, as you understand that project?
>
> A. I should believe that no part of it should be used for that purpose."

Professor Winslow testifies, Record, Vol. II, page 1671:

> "Then you would expect, Professor, that where the City of New York is now discharging sewage into the waters of the harbor with relative impunity by reason of there being a margin of dissolved oxygen to dispose of, that New York might be deprived of that margin by the presence of this discharge from the Passaic Valley Sewer?
>
> A. Exactly."

William P. Mason, Record, Vol. III, page 2009:

> "Q. And the more of the polluting matter which reaches New York Bay from the New Jersey side, which can be excluded, the larger will be the possible pollution by the City of New York with safety, is not that so?
>
> A. Why, it is true that if a certain amount of pollution be considered as going into New York Bay, and that the amount be constant, if you reduce that which comes from elsewhere than New York, why, it permits New York to dump in a larger quantity.

Q. And from that point of view it would be very desirable for the City of New York, and possibly the State of New York, to exclude all New Jersey sewage from the waters of New York Bay?

A. By the exclusion of all New Jersey sewage from the waters of New York Bay, it would of course give New York City a longer time before it was obliged to do something to prevent a nuisance."

Even more frank and undisguised is the testimony of Professor Phelps, Record, Vol. II, page 1633:

"Q. Then, except in the event of the hope for improvement in the science of purification, there is but very little hope of the City of New York getting its sewage out of the bay, in your opinion?

A. Yes, under present methods.

Q. And so, in your opinion, it becomes very desirable from New York's point of view, to prevent anybody from discharging sewage into New York Bay which will exhaust the possibilities of consumption by New York of the dissolved oxygen in it?

A. That would naturally be the attitude.

Q. You are not even giving us the benefit of the narrow 2 or 4 or 8 per cent. that the average determinations show?

A. I think that will be quite exhausted in a very few years.

Q. Is it not exhausted now; was it not exhausted at the time this stipulation was made?

A. It is going down each year. It will be exhausted before the Passaic Valley Sewer is in operation.

Q. And you think that, in the absence of these advances in the science, under the conditions that exist, New York City will itself have rendered the waters of the Bay of New York unfit to surround a great city?

A. With the small additions to help from the other surrounding communities, that is my belief, yes. In fact, I think that condition is practically reached today."

Turning now to the evidence of complainant's witnesses, as to the percentage of pollution to be expected from the discharge of a volume of sewage equal to that of the Passaic Valley, treated only in the manner specifically described in the stipulation, into the waters of New York Bay, we find the following: Professor Phelps, Record, Vol. II, page 1625:

"Assuming 700,000 as the present population it would be a little less than one-half of that exactly, seven-sixteenths.

Q. So that your limits would be what of the polluting effect upon the waters of this particular area?

A. About three and one-half to seven per cent. of the present pollution."

John W. Alvord, Record, Vol. III, page 1898:

"Q. Is it not a fact that it is an almost perfect effluent as described?

A. In some respects, yes, and in other respects, no.

Q. Well, now, in what respects no?

A. It is not perfect as to the impurities in solution, which will reduce the dissolved oxygen in the waters of the harbor.

Q. To what extent will it reduce the dissolved oxygen in the waters of the Upper Bay, taken as a whole?

A. I am unable to say with precision.

Q. Would you say it would exceed one per cent.?

A. I would not venture on any figures indicating a precise opinion. I would say, however, that bearing all the surrounding circumstances in mind, considering the amounts of pollution already existing in the harbor, and the sludge beds upon the bottom of the harbor, and that the emptying of this quantity of sewage, amounting as it will in 1940 to over 1,100 acre feet of sewage per day, it would, in my opinion, so reduce the dissolved oxygen of the harbor that large fields of water now on the verge of being insufficiently filled with oxygen would be reduced below permissible and preventable limits, and that nuisances already existing would thereby be increased, while other nuisances not now existing would be created."

It is of interest to note the views of this witness which appear on the next page of the Record as to why the stipulation would not be carried out. Record, Vol. III, 1899.

As might be expected in the case of theoretical laboratory experts, the gloomy predictions of the witnesses for the complainant have not materialized in the five years which have elapsed since they were made. At the time when the testimony was given the only processes under consideration for the treatment of the New York sewage were screening and sedimentation, Record, Vol. II, page 2174. No public calamity has overtaken New York in the last five years—on the contrary its growth and

prosperity have been unprecedented; no pestilence or even epidemics have occurred.

The explanation is given by Mr. George A. Johnson, testifying for the defendants, Record, Vol. III, page 2458, Folio 3600, as follows:

> "If the sewage is well mixed with the water adequate dilution in New York Harbor is afforded for the sewage of 18,000,000 people; furthermore, with such treatment as will be given the Passaic Valley sewage given to the sewage of New York, I believe this population can be doubled, practically speaking, provided every available opportunity to make use of the diluting powers of the Bay is grasped."

Accordingly, even the objectionable methods employed by the City of New York, when applied to a population of 5,000,000 people, has failed to overcome the almost limitless disposal powers of the waters of New York Harbor. In this connection we refer to the testimony of George A. Johnson, Record, Vol. III, page 2453, folio 3592. The whole of the testimony of this witness, which begins, Record, Vol. III, page 2445, folio 3578, we submit commends itself as most valuable and illuminating, by reason of the common sense and practical restraint exercised by this witness in offering his testimony.

When it is considered that the sewage of the Passaic Valley now reaches the waters of New York Bay and that eighty-four per cent. of it passes through the Kill von Kull into Upper New York Bay, Record, Vol. III, page 1730; sixteen per cent. through the Arthur Kill into Lower New York Bay, and that the effect of this sewage is now perceptible in the waters of New York Bay, Record.

Vol. II, page 1495-6; and that the contamination of the waters of Upper New York Bay by the sewage of New York City injuriously affects the State of New Jersey, Record, Vol. II, page 1552; it is readily understandable why complainant resorts to a claim of "legal right" to monopolize the waters of the Upper Bay under the compact of 1834. Complainant by the testimony of its own witnesses is shown to be without a shred of equity from every possible point of view.

With respect to the claim to legal rights under the compact of 1834, it must be noted that these claims must rest upon a purely legal basis if they are to be sustained, and that the only legal basis which would sustain them is one that would exclude from the use of the waters of Upper New York Bay, so far as sewage disposal is concerned, all the municipalities in all the territory of the State of New Jersey, without respect to location, and would exclude consequently Jersey City, Hoboken, Bayonne, and all the other municipalities on the shore of the Bay and the Hudson River from discharging sewage of any kind into the waters of New York Bay without a permit from the State of New York.

Such a claim on the part of the State of New York is manifestly inconsistent with the existence of sovereign rights in the State of New Jersey, coincident with its territorial limits as established by the compact of 1834 in the land under water in New York Bay.* This Court has expressly

* This Court has defined "sovereignty" in t
guage:-"The very meaning of sovereignty is that
sovereign makes law." American Banana Co. vs.
, 213 U. S.,347; See Kawananakoa vs. Polyblank,

waters of New York Bay for all purposes, including the right to discharge and dispose of its sewage therein. It is only the abuse of the common rights in the waters of New York Bay which are subject to equitable jurisdiction, and as the case stands under the evidence the State of New York is guilty of whatever abuse may now exist, rather than the State of New Jersey.

Before closing this topic, we think attention should be directed to the fact that complainant's brief is significant rather for what it omits to discuss than for what it does discuss. We think it must be manifest that the stipulation between the United States and the State of New Jersey and the Passaic Valley Sewerage Commissioners has a very important bearing upon the issues in this case. Nothing but a casual reference appears in complainant's brief to this stipulation, and no discussion appears as to its effect in determining what is in fact proposed by the defendants.

Of equal importance to the proper determination of this cause is the effect of the pollution of the waters of New York Bay caused by the City of New York. No reference appears in the brief to this most important topic.

The third notable omission is any mention of the case of *Missouri* vs. *Illinois*, 200 *U. S.* (26 *U. S. Sup. Ct. Rep.*, 268) determined in this Court, and which is of controlling effect upon this cause.

VI.

We respectfully submit that the Bill of Complaint should be dismissed for want of equity and as offering no equitable or legal basis for the relief prayed for by Complainant.

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Appendix I.

The Bill of Complaint Sets Out.

a. The boundary line between the States of New York and New Jersey, and the compact between the said States, ratified in 1834, establishing the boundaries between the said States, and containing certain other matters appearing in the compact, a copy of which is annexed to the bill of complaint as "Schedule A."

b. The length of the shore line of the State of New York on the upper bay as thirteen miles; a brief description of the surroundings of the said bay.

c. The population of the State of New York as 4,250,000 at the date of filing the bill, and the assessed value of the real and personal estate within said city.

d. The legislation of the State of New Jersey creating the Passaic Valley Sewerage District,

Chapter 48 of the Laws of 1902, a copy of which is annexed to the bill of complaint and marked "Schedule B"; together with Chapter 10 of the Laws of 1907, providing for the purification of the waters of the Passaic River within said District, a copy of which is annexed to the bill of complaint and marked "Schedule C."

e. That the Passaic River had become so corrupt and polluted from the sewage which emptied into it from the natural drainage area of the District as to be injurious to the health and comfort of the inhabitants of the adjoining territory.

f. A statement of the making and adoption of plans, specifications, etc., for the construction of a joint trunk or main intercepting sewer for collecting and discharging the sewage of the Passaic Valley Sewerage District at a point in New York Bay, about half a mile north of Robbins Reef light, on the westerly edge of the main ship channel; that the area of the Passaic Valley Sewerage District is 103.23 square miles. The population of the district in 1905 was 601,817 persons, which was estimated to increase to the number of 700,000 persons in 1911, and 1,640,000 in 1940; that the average daily amount of sewage from the drainage area of the Passaic River in 1905 was 89,343,000 gallons, and it was estimated for the year 1940 at upwards of 347,365,000 gallons in twenty-four hours.

g. That of thirty municipalities within the drainage area of the Passaic River, fourteen had consented to and approved of the plans of the Commissioners, and agreed to use the sewer for the drainage of their localities; and that the amount of sewage to be contributed by them at the outset would be 120,000,000 gallons daily.

h. That the matter intended to be discharged through the sewer will be not only sewage, but refuse discharged from a great number of manufacturing plants; that it is undefecated, disagreeable and offensive to the senses, poisonous and otherwise injurious to human beings and to other organisms and to fish and oysters, and injurious by its chemical or other action to wood and metal.

i. That the sewage so discharged in the waters of the Bay will be borne by the currents and tides throughout the Bay into the Hudson and East Rivers, and will be deposited on the bottom and on the shores and about the wharves and docks of New York City, and will pollute the same.

j. That the waters of New York Bay are largely used for bathing by the inhabitants of New York State and City, and that the threatened acts of the defendants will render the waters of New York Bay unwholesome and unsuitable for bathing.

k. That the commerce of the Port of New York includes the carriage of great numbers of passengers and enormous quantities of merchandise, and that anything tending to make the Bay less serviceable and less attractive to commerce by reason of the offensive and unwholesome emanations and the unsightly appearance of the waters and of the shores, wharves and docks, and by reason of the matter so discharged upon the hulls of vessels and upon the shores, wharves and docks, and by reason of the danger of disease and other danger to which travellers may be exposed through pollution of the water.

l. That the fisheries of the Bay of New York and of the Hudson River are extensive and valua-

ble, including oysters and clams; that the pollution of the Bay of New York by the discharge of sewage into it by the defendants would drive away many of the fish, and would poison and render unfit for food oysters, clams and other fish.

m. That the threatened action of the defendant would injure the health and impair the safety and comfort of the residents of the State of New York and of travellers and other persons resorting to the City of New York.

n. That the threatened actions of the defendant are in contravention of Section 75 of the public health law of the State of New York, a copy of which is annexed to the bill of complaint and marked "Schedule D."

The bill of complaint prays:

1. A perpetual injunction against the construction of the proposed sewer or any part of the same or of any other sewer designed to conduct into the waters of New York Bay the sewage or drainage of the Passaic Valley sewerage plant or works; and from discharging or procuring to be discharged into the said waters the sewage or drainage of the said District or any part thereof.

2. A temporary injunction during the pendency of the cause.

THE ANSWER.

1. Admits the corporate capacity of the complainant and defendants, as set out in the bill of complaint.

2. Admits the boundary line between the States of New York and New Jersey as stated in the bill

of complaint, and that a true copy of the compact between the two States, ratified in 1834, is annexed to the bill of complaint; but denies the legal effect claimed by complainant for the said compact, and asserts the right of the State of New Jersey, subject to the control of the Government of the United States for the protection of commerce and navigation, to construct and use sewers and conduits placed within the territory of the said State, under or through the waters of the said Bay.

3. It admits the boundaries of the Upper New York Bay, set out in the complaint, but insists that the said Bay is divided by the boundary line between the State of New York and the State of New Jersey, as fixed by the compact between the States, and that the said dividing line is the middle of the said waters between the said States. It further admits that the East River flows into the Upper Bay within the State of New York, and that the Hudson River flows into the said Upper Bay partly within the City of New York and partly within the City of Jersey City in the State of New Jersey; and says that defendants are not informed with respect to the length of the shore line of the State of New York on the Upper Bay. It admits the improvement of the shore front of the City of New York as set out in the bill of complaint, and insists that the shores of New Jersey are improved in like manner.

4. It denies any definite knowledge of the population of the City of New York or of the assessed value of its real and personal property.

5. It shows that the State of New Jersey lies in part upon the westerly side of the Bay of New

York, having a shore line of about seven miles, and that many of the vessels navigating the Hudson River and New York Bay are owned by inhabitants of the State of New York, many are owned by inhabitants of the State of New Jersey, and many of them sail from docks within the State of New York and within the State of New Jersey; and that the State of New Jersey has a shore line on the Bay of New York and on the Hudson River of about twenty-five miles in extent.

6. It admits the passage by the Legislature of New Jersey of Chapter 48 of the laws of 1902 and Chapter 10 of the laws of 1907, that copies of the acts are annexed to the bill of complaint and marked "Schedules B and C." It further admits that the occasion for the enactment of said laws was that the Passaic River had become so corrupt and polluted by the sewage which empties into it from the natural drainage area of the said river as to be offensive and injurious to health and to the comfort of the inhabitants of the adjoining territory.

7. It sets out the course of the Passaic River and alleges that it has been polluted by sewage and other polluting matter from the municipalities through which it flows between the Great Falls of the said river in the City of Paterson and the mouth of the said river in New York Bay, that an intolerable nuisance has been thereby created, which greatly depreciates the value of property located on or near said river.

8. It admits the preparation of plans and specifications for the construction of an intercepting sewer to take up and make disposition of the sewage

discharged into the waters of the said river and the streams tributary thereto from the municipalities situated in whole or in part within the said sewerage district, together with the estimates of the cost of construction, and the cost of maintenance thereof, and that it has submitted such plans and estimates to the governing body of each of said municipalities as in said act directed.

9. It says that no contract has been entered into under Chapter 10 of the laws of 1907, but admits that Passaic Valley Sewerage Commissioners is willing to and intends to enter into a contract with the said municipalities or one or more of them for the execution of the plans and works prepared and designed for said sewer.

10. It admits the giving of the notice to the municipalities and the inhabitants thereof required by Chapter 10 of the laws of 1907.

11. It admits that the plans for said intercepting sewer provide for its construction from the Great Falls in the City of Paterson to a point in the Bay of New York about five hundred feet north of Robbins Reef light on the westerly side of the main ship channel in the said Bay, and about one-quarter of a mile westerly from the line dividing the territory of the State of New York from that of the State of New Jersey; that the plans provided for the taking up of all the sewage and other polluting matter now discharged or which otherwise would hereafter be discharged into the waters of the said river; and that the capacity will be sufficient to take up and dispose of the said sewage, including 10% of the factory waste, for a period estimated at not less than thirty years; that the

population of the district is estimated for the year 1905 at 501,817 persons, for the year 1911 at 702,400 persons, and for the year 1940 at 1,649,440; that the maximum capacity provided for the sewer is 357,365,220 gallons daily, the average daily flow is estimated not to exceed 250,000,000 gallons.

12. Describes the pumping station to be located near the Newark Bay on the Newark Meadows, and the treatment to be therein given to the sewage, and says that it is intended after such treatment to discharge the effluent at the point above stated into the deep waters of New York Bay, within the territory of the State of New Jersey, and where there is ample volume of water thoroughly to assimilate and diffuse it without causing serious or offensive pollution, and without increasing the present pollution of the Bay of New York; that the discharge is not to be made through a circular opening 12 feet in diameter, as set out in the bill of complaint, but through a number of pipes, each of sufficient capacity to vent its quota of the effluent thus discharged, which discharge pipes will be extended in various directions and in varying lengths in the main channel, and will be provided with discharge openings venting the contents of the sewer in small units horizontally in the direction of the tidal currents of said Bay, over a sufficient area and by such number of vents as will provide a rapid assimilation of the discharge with a very large flow of the waters of the said Bay, which discharge will be made at not less than forty feet beneath the surface of mean high water in the Bay.

13. Sets out proceedings taken by the defendants during more than ten years immediately pre-

ceding for the purpose of relieving the Passaic River of its sewage pollution.

14. Shows that nearly all of the sewage discharged into the Passaic River finally reaches and discharges in the waters of New York Bay at or near Robbins Reef light, without any appreciable injury to said waters, and describes the reason why the discharge of the sewage into Newark Bay produces the injurious effect found therein.

15. Alleges that the waters of Newark Bay covering a considerable area of land are shallow and do not rapidly assimilate sewage discharged therein.

16. Sets out the condition of the Passaic River above the Great Falls at Paterson.

17. Asserts that the waters of the Bay of New York are capable of disposing harmlessly of the sewage of a population of at least twenty-five million people.

18. Sets out the method of the discharge of the sewage of the City of New York into the waters of the said Bay and of the Hudson and East Rivers; that the sewage, factory waste and other polluting matter so discharged by New York is of the same character as that discharged into the waters of the Passaic River, and that the volume of said matter so discharged exceeds the amount discharged into the waters of the Passaic River by as much as the population of the municipalities discharging into the said waters exceeds the population of the municipalities of the State of New Jersey within the Passaic Valley Sewerage District; and alleges that if any injury should occur from the discharge of sewage into the waters of the Bay of New York it

would be because of sewage, factory waste and polluting matter discharged by the municipalities of the State of New York into the waters of the Bay, discharged in a crude state, without screening or other treatment, at or near the surface of the Bay, and that if said sewage was treated in the manner proposed in the plans adopted by the defendant Commissioners for the sewage of the Passaic Valley District, no harmful effect would arise therefrom to persons or property within the State of New York or within the State of New Jersey.

19. Insists that the municipalities of the State of New York with the permission of the complainant are discharging vast quantities of crude sewage, factory waste and polluting matter directly into the waters of the Bay of New York, without screening and without sedimentation, and that they should not be heard to complain that the State of New Jersey proposes to discharge sewage in much smaller quantities, treated as set out in the answer hereto, into the waters of the said Bay within the State of New Jersey.

20. That the sewer will be laid, and the point of disposal of the sewage will be entirely within the territory of the State of New Jersey, and under its jurisdiction and control, and that the State of New Jersey has the legal right to authorize its construction and operation.

21. Asserts the right of the State of New Jersey to discharge sewage and factory waste into the Bay of New York to the same extent as the State of New York, and that the waters of the Bay of New York and the waters of Newark Bay constitute one bay or harbor.

22. Asserts the control by the United States for purposes of commerce and navigation over the lands and waters on the New Jersey side of the line dividing New York from New Jersey, as set out, and that said lands have been under the control and jurisdiction of the State of New Jersey, excepting as above stated, since the execution of the compact between the States.

23. That the title of the State of New Jersey to the lands under water has been recognized repeatedly by the United States.

24. Denies that sewage which may be deposited in the waters of the Bay of New York by the proposed sewer will be borne by the currents and tides throughout the Bay and into the Hudson and East Rivers, and will be deposited on the bottom and on the shores and about the wharves and docks of the City of New York, and that it will pollute the said waters, shores, wharves and docks.

25. Admits that fourteen of the twenty municipalities within the natural drainage area of the Passaic River have consented to the plans submitted and have signified their willingness to adopt and use the proposed sewer; denies that the amount of sewage which will be discharged by these municipalities will be 120,000,000 gallons daily, or that it will exceed 60,000,000 gallons daily; but admits that other municipalities within the drainage district propose to adopt and use the proposed sewer. Insists that the matter to be discharged through said sewer will contain not only the sewage of the said municipalities, but 10% of the factory wastes therein, and denies that the said sewage will be discharged indefecated, that it will be at the point

of discharge disagreeable and offensive to the senses, that it will be poisonous or otherwise injurious to human beings or other animal organisms, or to fish or oysters, and that it will be injurious by chemical or other action to wood and metal.

26. Denies knowledge of the use of the Bay of New York by residents of the State of New York for bathing, and that the intended acts of the defendant will render the waters of New York Bay unsuitable for bathing. It shows that the free bath houses of the City of New York are located along the shores of the said Bay and of the Hudson and East Rivers, and near the waters of the said Bay, in which the sewage of the municipalities is discharged in its crude state and near the point of such discharge.

27. Denies any knowledge of the truth of the allegations of the bill with reference to the commerce, traffic, imports, exports, contributions to the national revenue, etc., and further denies that any intended acts of the defendant will, if not restrained, tend to make the Bay of New York less serviceable or less attractive to commerce, and denies that the discharge of sewage as proposed will render the waters of the Bay offensive, or that any unwholesome emanations will come therefrom, or will cause the shores, docks, etc., to appear unsightly, or will injure the vessels or any other structures upon or bordering on said Bay.

28 and 29. Denies any intention to proceed with the construction of the sewer without first obtaining the consent of the Government of the United States, and sets out the application made to the Secretary of War for this purpose, and the various proceedings taken thereunder.

30. Denies that the intended acts of the defendants when carried out will injure the health and impair the safety and comfort of the residents of the State of New York, or be injurious to travellers and other persons resorting to the City of New York.

31. Denies knowledge of the standard value of the fisheries within the Bay of New York, including plantations of oysters or clam beds; denies that the proposed discharge of sewage by the defendants would pollute the waters of the Bay or drive away any of the fish, or would poison or render unfit for food any oysters or clams or other fish, or would impair or destroy the value of any fisheries which may be in the said Bay of New York or the waters contiguous and adjacent thereto.

32. Denies that any acts are threatened by the defendant until the works and construction shall have received the approval of the Secretary of War of the United States, and the construction shall have received the approval of the Chief Engineer of the War Department, and denies that the intended acts of the defendant are in contravention of Section 79 of the Public Health Law of the State of New York, and denies that said section has any application to the waters of the Bay of New York, particularly to the waters of the Bay of New York lying west of the boundary line between the State of New York and the State of New Jersey, and denies that the State of New York has authority to pass any law the object of which is to prevent the discharge of sewage from the State of New Jersey into the Bay of New York, over or upon lands owned by the State of New Jersey; denies that said public health law has any application to the acts

of defendants in the construction and use of sewers or conduits proposed to be constructed by the defendants.

33. Denies that the intended acts of the defendants, if repeated and continued, would result in irreparable injury to the complainant, or the health, safety and welfare of the inhabitants of the State of New York.

34. Sets out that the laws of the Government of the United States regulating the discharge of refuse, etc., in the tidal waters of the Harbor of New York expressly except the matters flowing from streets and sewers and passing therefrom in a liquid state into the tidal waters of the Harbor of New York or its adjacent or tributary waters.

35. General denial.

TO THE ANSWER THERE ARE ANNEXED:

1. Copy of a grant by the State of New Jersey to the United States of America for Ellis Island.

2. Copy of grant by the Riparian Commissioners of the State of New Jersey to the United States of the site for the Robbins Reef light.

3. Schedule embracing the special report of the Passaic Valley Sewerage Commissioners to the Governor of the State of New Jersey, submitted June 8, 1903.

REPLICATION.

In general form.

Appendix No. 2.

IN THE SUPREME COURT OF THE UNITED STATES.

October Term, 1909.

In Equity, No. 6, Original, on the Docket for said October Term.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,
vs.
THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.
} *Stipulation.*

The United States having intervened in the above entitled suit with the consent of the court, and it being desired by the United States and the Defendants in the suit to adjust the matters in controversy between them, in the manner and upon the terms and conditions hereinafter stated, and the State of New Jersey, by an act of its Legislature, approved on the eighth day of April, nineteen hundred and ten, having authorized the defendant, the Passaic Valley Sewerage Commissioners, to make this adjustment, it is now stipulated and agreed by and between the United States and the Passaic Valley Sewerage Commissioners, defendants in the suit, as follows:

First. The Passaic Valley Sewerage Commissioners agree with the United States that the sewage system to which the suit relates shall be constructed, maintained and operated, if at all, in accordance with the following requirements:

(a) Upon the line of the trunk sewer which it is proposed shall be constructed and at a point at or near the pumping station to be located on the Newark Meadows near the Newark Bay, it is stipulated and agreed that the sewage, waste and other matter passing through the said trunk sewer shall first pass through coarse screens to remove therefrom all large floating matter, and after passing through such coarse screens shall pass through a grit basin or basins where the heavy matter therein shall be taken out as far as practicable, from which basin or basins the sewage and other matter shall pass through self-cleaning mechanical screens having clear openings of not over 4/10 of an inch.

(b) As the sewage comes from the fine screens, it shall also pass through sedimentation basins. The sewage after passing through said grit basin and self-cleaning mechanical screens shall enter the sedimentation basins, or settling tanks consisting of a number of units, each approximately 225 feet long and 15 feet deep. Each tank will have a normal capacity of not less than 1,250,000 gallons, making an aggregate tank capacity sufficient to meet the requirements as stated herein. The tank capacity shall always be such as to provide a detention period of not less than one hour at the maximum rate of flow of the sewage and a detention period of the daily average flow of such sewage for not less than one hour and a half. The mean lineal velocities through said tanks shall not be over 0.5

inch per second for average flow, and 0.75 inch per second for the maximum flow. In addition to and in connection with these basins scum boards shall be provided to retain the floating matter, and proper and adequate devices shall be used to remove the retained scum and deposits from the settling basins; drawings of the general plan of said settling tanks (sedimentation basins) as proposed at the outset being herewith attached as Appendix A.

(c) The sewage and waste thus screened and settled is then to flow into a pump well, whence it is to be pumped under pressure through a tunnel to a point in the New York Bay near Robbins Reef light, at which point it is agreed that the matter passing through the said tunnel shall be dispersed into the waters of the New York Bay through a series of outlets discharging forty feet or more beneath the surface of the water at mean low tide. From the end of the tunnel connections shall be made with four or more discharge pipes extending across the current, spaced about one hundred feet apart, laid in trenches on the bottom of the Bay, and of a size decreasing in diameter from about six feet to two feet. On the top of these discharge pipes will be a series of not less than one hundred and fifty tees of a diameter not exceeding one foot, and spaced approximately ten feet apart. On each of these vertical tees shall be placed outlets arranged to discharge horizontally across the tidal current, and the extent of the dispersion area used for this system of outlet pipes shall cover at least 3.5 acres of the bottom of the Bay.

Second. The Passaic Valley Sewerage Commissioners further agree with the United States that

in the operation of said sewer system at all times the following results shall be secured, either through compliance with the requirements of the immediately preceding paragraphs, or through requisite lawful additional arrangements, viz.:

(1) There will be absence in the New York Bay of visibly suspended particles coming from the Passaic Valley sewage.

(2) There will be absence of deposits objectionable to the Secretary of War of the United States in the New York Bay coming from the Passaic Valley sewage.

(3) There will be absence in the New York Bay and its vicinity of odors due to the putrefaction of organic matters contained in the Passaic Valley sewage thus discharged.

(4) There will be a practical absence on the surface of New York Bay of any grease or color due to the discharge of the Passaic Valley sewage at the dispersion area or elsewhere.

(5) There will be no injury to the public health which will be occasioned by the discharge from the said sewer into the Bay of New York in the manner proposed and no public or private nuisance will be created thereby.

(6) The absence of injurious effect from said sewage discharge, upon the property of the United States situated in the Harbor of New York.

(7) The absence of reduction in the dissolved oxygen contents of the waters of New York Bay, resulting from the discharge of Passaic Valley sewage, to such an extent as to interfere with major fish life.

Third. The said Passaic Valley Sewerage Commissioners further agree with the United States that so long as said sewer system, or part thereof, is operated, the United States shall have through such representatives as may be designated by the Secretary of War at any time for such purpose, full opportunity to inspect the condition and working of the sewer system, with a view to determining whether this contract is being in all respects performed and that the said Passaic Valley Sewerage Commissioners will render such expert or other assistance as the United States may desire in the course and in the aid of such inspection and determination.

Fourth. The United States agrees with the Passaic Valley Sewerage Commissioners that forthwith upon the filing of this agreement, properly executed, in the office of the Clerk of the Supreme Court as a stipulation of the parties in the suit, it will discontinue its intervention in the above entitled suit and will cause its petition of intervention to be dismissed without prejudice, and will not again intervene in said suit.

Fifth. The United States and the Passaic Valley Sewerage Commissioners mutually agree that this contract shall not become effective in any part, except the next succeeding divisions, unless or until all such permits as would be requisite under the statutes of the United States for the construction, maintenance or operation of said sewer system without this contract are actually obtained from the United States, or unless or until such permits are made conditional upon compliance at all times with all the terms and requirements of the divisions of this contract numbered First and

Second, whether or not such permits contain other terms or conditions.

Sixth. The Passaic Valley Sewerage Commissioners hereby consent that full compliance at all times with the terms and requirements of the First and Second divisions of this contract be made express conditions of any permits issued by or on the part of the United States for construction, maintenance or operation of said sewer system, and agree with the United States that this contract shall establish such consent before all officers of the United States.

Seventh. It is agreed between the United States and the Passaic Valley Sewerage Commissioners that this contract shall bind and also shall enure to the benefit of the successors of the latter.

In witness whereof this instrument has been executed in triplicate; being signed in the name and on behalf of the United States by the Attorney General of the United States and in the name of and on behalf of the Passaic Valley Sewerage Commissioners by their president, and being sealed also on behalf of said Passaic Vallege Sewerage Commissioners with their corporate seal attested by their secretary; all on the fourteenth day of April, Nineteen Hundred and Ten.

THE UNITED STATES OF AMERICA,
By GEORGE W. WICKERSHAM,
Attorney General.

THE PASSAIC VALLEY SEWERAGE COMMISSIONERS,
By JULIUS A. LERKUECHER,
Chairman and President.

Attest:

(Seal) JOHN S. GIBSON,
Secretary and Clerk.

Appendix No. 3.

New York, March 25, 1909.

Passaic Valley Sewerage Commissioners, Prudential Building, Newark, N. J.

GENTLEMEN:

Pursuant to request, we beg to hand you herewith a statement covering the arrangements proposed for screening, sedimentation and outlet discharge pipes in New York Bay, together with the estimated degree of removal of floating and suspended matter and also the necessary extent of dispersion in the New York Bay water, in connection with the disposal of the sewage of the Passaic valley, as outlined in the report of your Commission in 1908.

This statement is prepared for the purpose of securing co-operative action to decide the details of this method, in a manner satisfactory to the parties in the pending suit between the States of New Jersey and New York and the United States, in accordance with the understanding arrived at during the conference held in the office of Attorney General O'Malley in New York City on March 11, 1909.

SCREENING.

At the end of the main trunk sewer near the pumping station it is proposed to have the sewage first flow through a basin where the heaviest matter in the sewage will be settled out. From this basin the sewage will flow through ordinary coarse screens, to remove all large floating matter. After

passing the coarse screens, it is proposed then to pass the sewage through self-cleansing mechanical screens, having clear openings of not over one-half of an inch.

SEDIMENTATION.

As the sewage comes from the fine screens, it will flow into sedimentation basins. These sedimentation basins are to be suitably sub-divided and of sufficient width to reduce the mean velocity of sewage flow to three inches per second when the district sewer is running half full, and the length of same is to be sufficient to retain such matter as will settle at this velocity.

In connection with these sedimentation basins, scum boards, to retain all floating matters, and adequate devices to remove at proper intervals the retained scum and deposits from all these basins, will be provided.

METHOD OF DISCHARGE INTO NEW YORK BAY.

The sewage thus screened and settled then flows into the pump wells, whence it is pumped under pressure through the tunnel to a point in New York Bay, near Robbins Reef light, at which point it is proposed to disperse it in the waters of the Bay (as shown on the plans in the 1908 report) through a series of outlets, discharging forty feet or more beneath the surface of the water at mean low tide.

From the end of the tunnel, connections will be made with four or more discharge pipes, extending across the current, spaced about 100 feet apart, laid in trenches on the bottom of the bay, and of a size decreasing in diameter from about 6 feet to 2 feet. On top of these discharge pipes will be a

series of about 150 tees, of a diameter of about one foot, and spaced approximately 10 feet apart. On each of these vertical tees it is proposed to place two outlets, and arranged to discharge horizontally across the tidal current. The extent of the dispersion area required for the system of outlet pipes will approximate 3.5 acres on the bottom.

ESTIMATED DEGREE OF REMOVAL OF FLOATING AND SUSPENDED MATTER.

We estimate that the combined effect of the several processes above described will be such as to remove from the raw sewage all of its floating and suspended matter of such character as might appear either as a sediment on the bottom of the bay or rise to the surface. The very finely divided suspended organic particles and the dissolved organic matters of the sewage will, under the proposed conditions of dispersion, be carried in the water until they are adequately oxidized and mineralized or consumed by low forms of marine life.

This estimate as to the degree of removal of floating and suspending matter, is based upon experiences at various places in the disposal of sewage by dilution, and particularly at Hamburg, Germany; Washington, D. C., and Chicago, Ill.

ESTIMATED NECESSARY EXTENT OF DISPERSION IN THE BAY.

The proposed dispersion is based upon the mixing of the sewage from 1,000 persons with at least 6 cubic feet per second of flowing bay water, which is an ample provision according to experience with the Chicago drainage canal, where the present dilu-

tion is only about 2 2/3 cubic feet per second of lake water per 1,000 persons connected with the sewers, even without screening or sedimentation.

The spacing of the outlet pipes is predicated upon the fact that throughout a vertical depth of 40 feet there is no time, even at slack water between the tides, when the bay water is quiescent for the entire depth, and upon the assumption that at such short periods, there will be a minimum mean velocity of the diluting bay water of at least three inches per second. For the rest of the time of velocity, and therefore the dilution, will, of course, be materially greater than 6 cubic feet per second per 1,000 persons.

FINAL EFFECT OF TREATMENT.

In our judgment, experiences in the disposal of sewage by dispersion in an adequate volume of oxygen-containing water in various parts of the world, show beyond any doubt whatever that the treatment above described for the disposal of the Passaic Valley sewage will give thoroughly satisfactory results in regard to the following:

(a) The absence in New York Bay of visible suspended particles coming from the Passaic Valley sewage.

(b) The absence in New York Bay of deposits coming from the Passaic Valley sewage.

(c) The absence in New York Bay of odors due to the putrefaction of organic matters contained in the Passaic Valley sewage.

(d) The practical absence on the surface of New York Bay of any grease or color due to the

discharge of Passaic Valley sewage at the dispersion area or elsewhere.

Respectfully presented,

(Signed) RUDOLPH HERING,
GEORGE W. FULLER,
EDLOW W. HARRISON.

Appendix No. 4.

The agreement entered into between the Commissioners appointed by this State and the Commissioners appointed by the State of New Jersey, to settle the boundary line between New York and New Jersey in the words following, viz.: "Agreement made between the Commissioners on the part of the State of New York and the Commissioners on the part of the State of New Jersey, relative to the boundary line between the two States.

"Agreement made and entered into by and between Benjamin F. Butler, Peter Augustus Jay and Henry Seymour, Commissioners duly appointed on the part and behalf of the State of New York, in pursuance of an act of the Legislature of the said State entitled 'An Act concerning the territorial limits and jurisdiction of the State of New York and the State of New Jersey,' passed January 18th, 1833, of the one part, and Theodore Frelinghuysen, James Parker and Lucius Q. C. Elmer, Commissioners duly appointed on the part and behalf of the State of New Jersey, in pursuance of an act of the Legislature of the said State, entitled 'An Act for the settlement of the territorial limits and jurisdiction between the States of New Jersey and New York,' passed February 6th, 1833, of the other part.

"Article first. The boundary line between the two States of New York and New Jersey, from a point in the middle of Hudson River opposite the point on the west shore thereof, in the forty-first degree of north latitude, as heretofore ascertained and marked, to the main sea, shall be the middle of the said river of the Bay of New York of the waters between Staten Island and New Jersey, and of Raritan Bay to the main sea, except as hereinafter otherwise particularly mentioned.

"Article second. The State of New York shall retain its present jurisdiction of and over Bedlow's and Ellis' islands, and shall also retain exclusive jurisdiction of and over the other islands lying in the waters above mentioned, and now under the jurisdiction of that State.

"Article third. The State of New York shall have and enjoy exclusive jurisdiction of and over all the waters of the Bay of New York, and of and over all the waters of Hudson River lying west of Manhattan Island and to the south of the mouth of Spuyten Duyvel Creek, and of and over the lands covered by the said waters to the low water mark on the westerly or New Jersey side thereof; subject to the following rights of property and of jurisdiction of the State of New Jersey, that is to say:

"1. The State of New Jersey shall have the exclusive right of property in and to the land under water lying west of the middle of the Bay of New York and west of the middle of that part of the Hudson River which lies between Manhattan Island and New Jersey.

"2. The State of New Jersey shall have exclusive jurisdiction of and over the wharves, docks,

and improvements made, and to be made, on the shore of the said State, and of and over all vessels aground on said shore or fastened to any such wharf or dock; except that the said vessels shall be subject to the quarantine or health laws, and laws in relation to passengers of the State of New York, which now exist or which may hereafter be passed.

"3. The State of New Jersey shall have the exclusive right of regulating the fisheries on the westerly side of the middle of the said waters, provided that the navigation be not obstructed or hindered.

"Article fourth. The State of New York shall have exclusive jurisdiction of and over the waters of the Kill von Kull, between Staten Island and New Jersey, to the westernmost end of Shooters' Island in respect to such quarantine laws and laws relating to passengers as now exist or may hereafter be passed under the authority of that State, and for executing the same; and the said State shall also have exclusive jurisdiction, for the like purposes, of and over the waters of the sound, from the westernmost end of Shooters' Island to Woodbridge Creek, as to all vessels bound to any port in the said State of New York.

"Article Fifth. The State of New Jersey shall have and enjoy exclusive jurisdiction of and over all the waters of the sound between Staten Island and New Jersey, lying south of Woodbridge Creek, and of and over all the waters of Raritan Bay lying westward of a line drawn from the lighthouse at Princes Bay to the mouth of Mattawan Creek, subject to the following rights of property and of jurisdiction of the State of New York:

"1. The State of New York shall have the exclusive right of property in and to the land under water, lying between the middle of the said waters and Staten Island.

"2. The State of New York shall have the exclusive jurisdiction of and over the wharves, docks and improvements made and to be made, on the shore of Staten Island; and of and over all vessels aground on said shore, or fastened to any such wharf, or dock, except that the said vessels shall be subject to the quarantine or health laws and laws in relation to passengers of the State of New Jersey which now exist, or which may hereafter be passed.

"3. The State of New York shall have the exclusive right of regulating the fisheries between the shore of Staten Island and the middle of the said waters, provided that the navigation of the said waters be not obstructed or hindered.

"Article Sixth. Criminal process issued under the authority of the State of New Jersey, against any person accused of an offense committed within that State; or committed on board of any vessel being under the exclusive jurisdiction of that State as aforesaid; or committed against the regulations made or to be made by that State, in relation to the fisheries mentioned in the third article; and also civil process issued under the authority of the State of New Jersey against any person domiciled in that State, or against property taken out of that State to evade the laws thereof; may be served upon any of the said waters within the exclusive jurisdiction of the State of New York, unless such person or property shall be on board a

vessel aground upon, or fastened to the shore of the State of New York, or fastened to a wharf adjoining thereto; or unless such person shall be under arrest, or such property shall be under seizure, by virtue of process or authority of the State of New York.

"Article Seventh. Criminal process issued under the authority of the State of New York, against any person accused of an offense committed within that State; or committed on board of any vessel being under the exclusive jurisdiction of that State as aforesaid; or committed against the regulations made or to be made by that State, in relation to the fisheries mentioned in the fifth article; and also civil process issued under the authority of the State of New York against any person domiciled in that State or against property taken out of that State to evade the laws thereof; may be served upon any of the said waters within the exclusive jurisdiction of the State of New Jersey, unless such person or property shall be on board a vessel aground upon, or fastened to the shore of the State of New Jersey, or fastened to a wharf adjoining thereto; or unless such person shall be under arrest, or such property shall be under seizure, by virtue of process or authority of the State of New Jersey.

"Article Eighth. This agreement shall become binding on the two States when confirmed by the legislature thereof respectively, and when approved by the Congress of the United States.

"Done in four parts (two of which are retained by the Commissioners of New York, to be delivered to the Governor of that State, and the other two of which are retained by the Commissioners of New Jersey, to be delivered to the Governor of that

State) at the City of New York, this sixteenth day of September, in the year of our Lord one thousand eight hundred and thirty-three, and of the independence of the United States, the fifty-eighth.

(Signed)

"B. F. Butler,
"Peter Augustus Jay,
"Henry Seymour,
Theo. Frelinghuysen,
James Parker,
Lucius Q. C. Elmer."

Office Supreme Court, U. S.
MAR 25 1918
JAMES D. MAHER,
CLERK.

NO. 2 ORIGINAL.

IN THE

Supreme Court of the United States.

OCTOBER TERM, 1917.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,

vs.

THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

Brief and Argument for Complainants on Final Hearing.

MERTON E. LEWIS,
Attorney General of the State of New York,
For Complainants,

CHARLES E. HUGHES,
WILLIAM J. O'SULLIVAN,
of Counsel.

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No. 3 Original—October Term, 1917.

Supreme Court of the United States.

The People of the State of New York,
Complainants,

vs.

The State of New Jersey and Passaic Valley Sewerage Commissioners,
Defendants.

BRIEF FOR COMPLAINANTS ON FINAL HEARING.

This is an original bill to restrain the construction and operation of a trunk line sewer to be built for the purpose of conducting the sewage of the Passaic Valley Sewerage District, of New Jersey, to a point in New York Bay, near Robbins Reef Light (that is, in the Upper New York Bay off Staten Island) and there discharging the same to the serious injury of the People of the State of New York (p. 2)*.

The bill was filed on October 17, 1908, and the defendants filed a joint and several answer (p. 29). The United States was permitted to intervene on January 25, 1909

*The references, unless otherwise noted, are to the Transcript of Record.

(p. 82), and on stipulation (p. 109) its petition of intervention was dismissed without prejudice on April 14, 1910 (p. 112).

In 1911, Mr. James D. Maher was appointed Commissioner to take testimony (p. 147), and the taking of testimony was completed in 1913 (p. 164).

The testimony is voluminous and considerable time was required to prepare the record for presentation to the court. For other reasons, unnecessary now to particularize, but which do not in the slightest degree detract from the extreme importance of this case to the interests of the People of the State of New York, the hearing has been postponed.

The case is now on for final hearing.

Statement.

This case does not involve the pollution of waters by sewage received in the ordinary manner from riparian communities. Thus, it does not relate to the sewage of Jersey City, Hoboken and Weehawken, communities bordering on the Hudson River which sewer into the adjacent waters.

We are here concerned with an enterprise for the construction and operation of an artificial conduit by which it is proposed to collect organic filth and trade waste from about thirty municipalities in the Passaic Valley, and, instead of that sewage being disposed of by local treatment by the separate municipalities or emptied into adjacent waters, it is to be conducted through this artificial conduit or trunk sewer for about twenty-six miles, and then this enormous volume of macerated and putrid filth in concentrated condition is to be discharged at the edge of the main ship channel of the Upper New York Bay (where the tidal currents will carry it into the East River and Hudson River) at a rate which in the near future may easily amount to over 350,000,000 gallons a day.

This, the complainants insist, would constitute a most serious nuisance—injurious to health, property, navigation and commerce—of which the People of the State of New York are entitled to complain.

Moreover, while the point of discharge, so far as the land under water is concerned, is within the territorial limits of New Jersey, being about one quarter of a mile from the boundary line between the States of New York and New Jersey, the discharge is into waters over which New York has exclusive jurisdiction under the Compact of 1833 (See Laws of 1834 [New York], Chapter 8; Laws of 1834 [New Jersey], p. 118; Act of Congress, June 28, 1834, 4 Stat., 708; see Appendix, *infra*, pp. 113-117).

Article third of this Compact provides:

> "The state of New York shall have and enjoy exclusive jurisdiction of and over all the waters of the bay of New York, and of and over all the waters of Hudson river lying west of Manhattan island and to the south of the mouth of Spuyten Duyvel creek, and of and over the lands covered by the said waters to the low water mark on the westerly or New Jersey side thereof; subject to the following rights of property and of jurisdiction of the state of New Jersey, that is to say:
>
> 1. The state of New Jersey shall have the exclusive right of property in and to the land under water lying west of the middle of the bay of New York and west of the middle of that part of Hudson river which lies between Manhattan Island and New Jersey.
>
> 2. The state of New Jersey shall have the exclusive jurisdiction of and over the wharves, docks and improvements made, and to be made, on the shore of the said state, and of and over all vessels aground on said shore or fastened to any such wharf or dock; except that the said vessels shall be subject to the quarantine or health laws, and laws in relation to passengers, of the state of New York, which now exist or which may hereafter be passed.

3. The state of New Jersey shall have the exclusive right of regulating the fisheries on the westerly side of the middle of the said waters, provided that the navigation be not obstructed or hindered."

Pleadings.

The bill of complaint alleges the facts with respect to the sewerage project, charges that its execution will constitute a nuisance, and asks for a permanent injunction. The bill sets forth the injury to the People of the State of New York, their health, property interests, and commerce, and seeks the relief to which the State is entitled both upon equitable principles relating to a nuisance of this character and by reason of its jurisdictional rights reserved under the compact with New Jersey.

The defendants, in their joint and separate answer, admit the sewerage project (the details of which will be later considered) and deny that a nuisance will be created or the rights of the complainants infringed.

Salient Features of Proposed Sewerage Plan. Although the testimony is voluminous, the outstanding and controlling facts relating to this enterprise may be succinctly stated.

(1) The Passaic Valley Sewerage District.

This was constituted by Laws of 1902 (New Jersey), Chapter 48, so as to comprise described portions of Essex, Passaic, Bergen and Hudson counties. It embraces most of the watershed of the Passaic River from its mouth at the head of Newark Bay to the west line of the City of Paterson. It includes the cities of Newark, Passaic, Paterson and Orange, as well as many populous boroughs and villages, or about thirty communities. The general outline of the district is a parallelogram about 17 miles long and

6 miles wide. The total area regarded as tributary to the proposed trunk sewer is about 103.2 square miles, but it should be noted that the total area covered by the thirty communities is about 140 square miles (Vol. 2, p. 1250).

The population in this district in the year 1910 was 734,396 (*Id.*, p. 1251). It appears that the rate of growth of population has exceeded the estimate of the Passaic Valley Sewerage Commission, which was only 702,400 for the year 1911 and 1,649,440 for the year 1940. It has been estimated that at the present rate of growth the population in 1940 will be nearer to 2,000,000, and hence that the daily quantity of sewage to be discharged as proposed will be correspondingly increased (*Id.*, pp. 1282, 1283).

By Laws of 1907 (New Jersey), Chapter 10, the Passaic Valley Sewerage Commissioners were authorized to prepare plans, etc., and to enter into contracts with the municipalities within the district. Plans for the joint intercepting sewer in question were accordingly made by the Commissioners, and by 1911 fifteen of the municipalities within the district had executed the contract for the construction of the sewer. These included the cities of Newark, Passaic and Paterson and certain boroughs and towns (Vol. 3, p. 2625).

(2) Present sewerage conditions within the Passaic Valley District.

The sewage of the various municipalities within the district has hitherto been received by the Passaic River. This river rises in the northern part of New Jersey, and, running in a southeasterly direction through the counties of Passaic, Bergen, Hudson and Essex, discharges its waters into Newark Bay (Vol. 1, p. 32). The various communities have not disposed of their sewage jointly, but separately in the usual manner. The Passaic River has

become seriously polluted, and since 1896 the question of its purification has been under consideration.

But neither the fact that the waters of the Passaic River find their way through Newark Bay and the Kill van Kull and the Arthur Kill into the Upper and Lower New York Bays, respectively, nor the importance of improving the present condition of the Passaic River, furnishes any excuse for the transfer of this polluting combination of sewage to the Upper New York Bay as proposed.

It is said in the defendants' answer (p. 36) "that all or nearly all of the sewage or other polluted matter which is discharged into the Passaic River, directly or indirectly, below the Great Falls in the City of Paterson, now passes down through the said river and thence in the Newark Bay and finally reaches and is discharged into the waters of the Bay of New York at or near Robbins Reef Light without any appreciable injury to said waters, and without causing any nuisance." This statement is completely met by the eminent scientist, Professor William T. Sedgwick, who testifies (referring to this paragraph in the answer) as follows (Vol. 3, pp. 2253, 2254):

> "This statement, while plausible, is absolutely contrary to fact, for it is not true that the sewage and polluted matter discharged as described now passes down through the Passaic River, thence into Newark Bay, and finally into the waters of the Bay of New York. If it did so there would be no nuisance in the Passaic and no need for the expenditure of the vast sum contemplated by the Passaic Valley Commission. On the contrary, the facts are that the polluting matter here described is, for the most part, retained within the Passaic River, where it produces the nuisance which it is designed to abate, and does not even reach Newark Bay itself, still less the Kill van Kull or New York Bay. It is for this reason, in fact, that a nuisance exists within the Passaic River, and it would be much nearer the truth to state that the sewage and other polluting

material referred is now retained within that river and there partially but insufficiently purified. The Passaic River is in effect an elongated septic tank or sewage purification plant, the effluent from which is emptied first into the Newark Bay, where it is further purified and largely diluted, and from which it eventually, thus purified and diluted, finds its way into the Kill van Kull, and thence, after still further dilution and purification, into New York Bay itself."

Again, it would have been entirely feasible to relieve the conditions of the Passaic River by appropriate local treatment by each municipality. It is significant that Mr. Rudolph Hering, originally one of the engineers of the Passaic Valley Sewerage Commission, and one of the originators of the project in question (Vol. 4, p. 3116), after a comprehensive study of sewage disposal systems both in Europe and in the United States, changed his view and testified and there was a better method of treatment (Vol. 3, pp. 2485-2871). It does not even appear that the proposed method is the more economical; there is evidence to the contrary. As was said by Mr. Theodore Horton, an eminent expert (Vol. 3, p. 2292), who in 1902 was in charge of the Passaic Valley trunk sewer (Vol. 3, pp. 2298, 2304):

"In my opinion, the project such as is proposed is not necessary, nor is it a desirable or economical way to dispose of the Passaic Valley sewage."

What has been accomplished in local sewage disposition is illustrated in the interesting report by Mr. Fuertes (an engineer of wide experience) to the Joint Committee of Orange, Montclair and East Orange (New Jersey) with respect to what had been accomplished at Essen and other places. He said (Vol. 5, p. 4205):

"As to the absence of nuisance around installations of properly designed Imhoff tanks the best

evidence is to be found in and around the City of Essen, Germany, where numerous such plants are situated in densely populated districts. By reference to Figure 1, which is a photograph of the Essen-North plant, it will be seen that directly back of the works is a row of large buildings, several stories in height. These stand about 500 feet from the tanks treating the sewage from 180,000 people, and are high-class apartment houses. Figure 3 shows the plant at Recklinghausen, which receives the sewage from 26,000 people. This little plant stands on an area considerably less than an acre in extent, the area of the tanks being 0.05 acre and of the sludge drying beds 0.10 acre. The house close beside the plant is the residence of the superintendent of the works. On the opposite side of the works from the superintendent's house and, as I recollect the location, not more than 500 or 600 feet away, is a very fine detached residence; others are located around the same general neighborhood at various distances from the works, as can be seen in Figure 4. No complaint has ever been made of odors at this plant, nor could I learn of anyone living in the vicinity who had found anything to object to about the works."

In truth, there is no exigency whatever which can be urged in justification of this method of combining the sewage of all these communities, and, after collecting it into a joint trunk line sewer, then discharging it into the waters of Upper New York Bay.

The point is that whatever injury the New Jersey communities may suffer through the nuisance of a polluted stream, they have sought to transfer to New York by creating in its harbor a nuisance of an intolerable character.

(3) Present conditions in New York Harbor.

The harbor of New York consists of the Lower Bay, the Upper Bay, the East River, the lower reaches of the Hud-

son River, the Kill van Kull, the Arthur Kill, Newark Bay and Jamaica Bay. The Lower Bay is situated at a re-entrant angle of a coast line and is a broad expanse of water open to the Atlantic Ocean. The Upper Bay is joined to the Lower Bay by a narrow channel or strait known as The Narrows. The Narrows, the Arthur Kill and the Kill van Kull are the waters which surround the Borough of Richmond, of the City of New York, commonly known as Staten Island. The Upper New York Bay is a body of water north of The Narrows into which flows the Kill van Kull, the Hudson River and the East River. Newark Bay is joined by the Arthur Kill to the Lower New York Bay and by the Kill van Kull to the Upper New York Bay, and into Newark Bay flow the Hackensack and the Passaic Rivers. The point of discharge of the proposed trunk line sewer is about five hundred feet north of Robbins Reef Light. This light is in Upper New York Bay at a distance of a little less than one mile northeast of the northeastern corner of Staten Island, or Richmond Borough, of the City of New York. It is about two miles from the Brooklyn shore and about 3.6 miles north of Fort Wadsworth on the west side (or Staten Island side) of The Narrows.

The extraordinary contention is made by the defendants that the existing condition of the Bay of New York, by reason of the sewage it already receives, deprives the State of New York of all right to complain of the vast increase in pollution to be caused through this abnormal addition of the combined sewage of the Passaic Valley. The truth is, as we conceive it, that the existing conditions in the harbor of New York, instead of depriving the complainant of a right to object, make it absolutely essential for the protection of health and commerce that no such additional pollution shall be tolerated. The fact that the waters of the Hudson and the East Rivers, which flow into

New York Bay carry the sewage of great riparian communities is a reason not for permitting this threatening addition from the Passaic Valley, but for preventing it.

At the present time there are twelve communities in the State of New Jersey discharging sewage directly into upper New York Bay, the Kill van Kull and the lower portion of the Hudson River. And there are eleven communities in the State of New York discharging sewage directly into upper New York Bay, the East River, the Harlem River and the lower portion of the Hudson River below the north line of Yonkers (Vol. 2, p. 1253). The sewerages of the riparian cities of Hoboken, Weehawken and Jersey City (all in New Jersey) are very bad and largely because of a defective sewerage system (Vol. 3, p. 1745). The New York Harbor waters now receive 900,000,000 gallons of sewage a day from about 6,000,000 people in its riparian communities (Vol. 2, p. 1644). But, of course, this sewage is not combined but is discharged into the adjacent waters at various points in a very wide area. The total deposits received from these riparian communities amount to about 1,500 tons of solid material daily, and the result is a general pollution of New York Harbor waters. All the sewage discharged into these waters from the riparian communities is what is described by the sanitary engineers as "fresh sewage." That is, the organic refuse reaches the water in from fifteen to thirty minutes after leaving the animal body (Vol. 3, p. 2352).

When organic wastes are discharged into bodies of water, they are disintegrated by the functional action of bacteria into simpler elements. The character of this disintegration process is dependent upon the amount of oxygen present in the waters in a dissolved state. If the dissolved oxygen is present in sufficient quantity aerobic bacteria disintegrate the organic matter with the aid of the oxygen into harmless and simpler elements. If the oxygen content of the waters has been seriously depleted aerobic

bacteria are unable to function and the work of disintegration is then completed by an-aerobic bacteria, and the decomposition products of their functional activity is dangerous to public health and injurious to property (Vol. 3, p. 1939; 1996; 2257). The dangers from this latter condition are pestilence, and the destructive erosions of paints and metals on ships and other property (*Id.*, pp. 1951, 1953, 1961, 1971, 2298, 2305).

The waters in New York's Upper Bay are brackish. They consist of about equal parts of salt and fresh water. Brackish waters have the lowest digestive power for organic refuse. The reason for this is that the bacteria that are efficient in fresh water are either killed or rendered moribund by the presence of saline matters in the admixture of salt water, while the bacteria that flourish in salt water are either destroyed or become inert in the presence of fresh water. These facts render brackish water the least desirable for the discharge of organic refuse with a view to its final disposition therein (*Id.*, pp. 1322, 1323).

The tidal range in New York Harbor is about four feet (Vol. 2, pp. 1059, 1062). The tidal prism is the volume of water between high water level and low water level. The depths of water in New York Harbor are variable and only about 58% has a depth of over twelve feet (*Id.*, p. 1051). Only a small portion of the water in the harbor is changed at each tidal cycle (*Id.*, p. 1052). Between 72% and 80% of all the water that comes in on a flood tide is water that has already been in the harbor and went out on a preceding ebb tide heavily polluted (*Id.*, pp. 1055, 1056; Vol. 3, pp. 2027, 2374). The volume of water below low water level is continuously in the harbor, is heavily polluted and is subject to no refreshing action from the incoming flood waters, except what it can gain from 20% to 25% of those flood waters.

The report which has been marked "Complainant's Exhibit No. 91" sets forth the salient features of the tidal

phenomena in the Harbor of New York as worked out after nearly four years of continuous study, during which all observations since 1858 were carefully studied and interpreted (Vol. 2, p. 1056). For every month in the year a record was kept of the quantity of water which will return on the ebb. There were actual measurements made four times a day at stated intervals at eleven different stations throughout the harbor and were carried out continuously (*Id.*). An extended series of float observations were conducted to determine the length of time sewage discharges were retained in the harbor waters prior to being deposited on the bottoms of these waters. The results shown by these float observations were that sewage matter discharged into the Hudson River took six to seven days to reach the Upper Bay of New York, and that like matter discharged into the East River averages about nine days before reaching the Upper Bay. And that of all the floating organic or other matter discharged into New York's Upper Bay and carried by the ebb to the Lower Bay, or to the Atlantic Ocean, that 75 per cent to 80 per cent returns on the incoming flood tide and adds its pollution to the already overcontaminated harbor waters (Vol. 1, 895-951; Vol. 2, 913-938; 1053, 1054, 1065; Vol. 3, 2027, 2374).

These plotted oscillations are visualized in Complainant's Exhibits Nos. 89 and 90 (Vol. 4, p. 3388).

The harbor waters of New York are at the present time overburdened by sewage pollution from the contributions of organic matter discharged by the riparian communities thereon. This condition is apparent to even laymen using these waters for either business or pleasure purposes.

(4) The defendants' plan for a trunk sewer from the Passaic Valley to the Upper New York Bay.

There is no dispute as to the physical character of this proposed Trunk Sewer. The defendants' answer admits

and shows that the plans adopted by them and submitted by them to the municipalities described:

> *"provide for the construction of a main intercepting sewer or sewers extending from the Great Falls of the said river in the City of Paterson, following generally the course of the said river to the City of Newark and from thence across the Newark Meadows to the Newark Bay and from thence by a tunnel to be constructed under the waters of the said bay and the lands covered by its waters and under the Cities of Bayonne and Jersey City and through the soil underlying the waters of the Bay of New York to a point in the said Bay about 500 feet north of Robbins Reef Light on the westerly side of the main ship channel in the said Bay and of the line so established, as aforesaid, dividing the territory of the two states within the said Bay of New York, and about one-quarter of one mile westerly from the said line"* (p. 33).

It thus appears that the sewage, instead of being suitably treated in each municipality, is collected and combined in this trunk line, or intercepting, sewer. This combined sewage is treated together and only at one point, that is, on the Newark Meadows near Newark Bay. At that place, there is to be installed a pumping station for the purpose of obtaining a sufficient height and pressure to discharge the matter passing from it into and through the tunnel to the place or point of discharge in Upper New York Bay. The manner of treatment, and the manner of discharge, are set forth in the stipulation entered into with the Government of the United States.

> "(a) Upon the line of the trunk sewer which it is proposed shall be constructed, and at a point at or near the pumping station to be located on the Newark Meadows near the Newark Bay, it is stipulated and agreed that the sewage, waste and other matter passing through the said trunk sewer shall

first pass through coarse screens to remove therefrom all large floating matter, and after passing through such coarse screens shall pass through a grit basin or basins where the heavy matter therein shall be taken out as far as practicable, from which basin or basins the sewage and other matters shall pass through self-cleansing mechanical screens having clear openings of not over 4/10 of an inch.

"(b) As the sewage comes from the fine screens, it shall also pass through sedimentation basins. The sewage after passing through said grit basin and said self-cleansing mechanical screens shall enter the sedimentation basins or settling tanks consisting of a number of units, each approximately 225 feet long and 15 feet deep. Each tank will have a normal capacity of not less than 1,250,000 gallons, making an aggregate tank capacity sufficient to meet the requirements as stated herein. The tank capacity shall always be such as to provide a detention period of not less than one hour at the maximum rate of flow of the sewage and a detention period of the daily average flow of such sewage for not less than one hour and a half. The mean lineal velocities through said tanks shall not be over 0.5 inch per second for average flow, and 0.75 inch per second for the maximum flow. In addition to and in connection with these basins scum boards shall be provided to retain the floating matter, and proper and adequate devices shall be used to remove the retained scum and deposits from the settling basins; drawings of the general plan of said settling tanks (sedimentation basins) as proposed at the outset being herewith attached as Appendix A.

"(c) The sewage and waste thus screened and settled is then to flow into a pump well, whence it is to be pumped under pressure through a tunnel to a point in the New York Bay near Robbins Reef Light, at which point it is agreed that the matter passing through the said tunnel shall be dispersed into the waters of the New York Bay through a

series of outlets discharging forty feet or more beneath the surface of the water at mean low tide. From the end of the tunnel connections shall be made with four or more discharge pipes extending across the current, spaced about one hundred feet apart, laid in trenches on the bottom of the Bay, and of a size decreasing in diameter from about six feet to two feet. On the top of these discharge pipes will be a series of not less than one hundred and fifty tees of a diameter not exceeding one foot, and spaced approximately ten feet apart. On each of these vertical tees shall be placed outlets arranged to discharge horizontally across the tidal current, and the extent of the dispersion area used for this system of outlet pipes shall cover at least 3.5 acres of the bottom of the Bay." (Complainants' Exhibit No. 135; Vol. 5, pp. 4006-4007).

The stipulation also contains certain covenants that through the above-stated requirements, "or through requisite, lawful additional arrangements," certain results with respect to immunity from injury would be guaranteed.

The inadequacy of this stipulation to secure proper protection, and its complete insufficiency as a defense, is abundantly established (*Infra*, pp. 75-85).

(5) Consequences.

It is the contention of the complainants that the discharge from the Passaic Valley trunk sewer outfall in the Upper New York Bay will create a public nuisance injurious to the public health and comfort of the citizens of the State of New York, and particularly of the City of New York. That it will injure commerce by the formation of enormous sewage fields, giving off offensive and unwholesome emanations injurious to both health and property. That this sewage discharge will injure the hulls of vessels and wharves, docks and other structures, the property of citizens of New York. That this discharge and the

poisonous gases emanating therefrom will expose our citizens, and travelers coming on business or pleasure to our City and State, to the dangers of disease, as well as annoyance and discomfort, through the excessive pollution of our harbor waters. That this discharge will either drive away or poison fish used for food that swim in the waters, or the oysters, clams and other fish that now exist in large areas throughout our harbor waters, and that it would impair and destroy the value of our fisheries, now the property of our citizens. That the dangers to public health, the injuries to property and the menace to the commercial and industrial prosperity of New York are incalculable and irreparable.

We present the following points:

(1) The complainants have established that the proposed enterprise will create a nuisance of the most serious character, injurious to health, property and commerce.

(2) The stipulation between the Passaic Valley Sewerage Commissioners and the Government of the United States wholly fails to afford assurance of protection.

(3) The existing condition of the waters of the Bay of New York furnishes no justification for the creation of this nuisance.

(4) The State of New York is entitled to maintain this bill, and to secure the relief asked (a) upon principles which may be deemed to be applicable to controversies between States, irrespective of the compact of the year 1833 with the State of New Jersey, and (b) by virtue of the exclusive jurisdiction reserved to the State of New York under that compact.

***First.*—The complainants have established that the proposed enterprise will create a nuisance of the most serious character, injurious to health, property and commerce.**

The record in this suit comprises the testimony of a long array of the most eminent sanitarians; consulting hydraulic and sanitary engineers; biologists; chemists; bacteriologists; and kindred scientists. It presents the results of a large amount of original scientific work, and analyzes the various methods for the disposal of domestic waste and trade refuse, setting forth scientifically their advantages or efficiency. A comprehensive series of studies of New York harbor waters are set forth in detail, embracing over 4,000 chemical analyses at all depths and more than 2,000 bacteriological determinations, together with a long series of microscopical examinations of both the waters and the sludge deposits beneath the waters. Every marine harbor on the Atlantic seaboard from Maine to Cuba has been investigated by a committee of eminent men. Tidal phenomena and contaminated local conditions have been studied and their peculiarity in aggravating or modifying the sanitary problems are presented.

To the lengthy series of oxygen determinations, bacterial counts and salinity studies are added and detailed groups of *diffusion* experiments and *dispersion* observations. These are supplemented by investigations of sewage oscillation and deposits. The disintegration of chemical products from sludge accumulation, with their injurious effects on paints and metals and the dangers inherent to anaerobic decomposition changes of organic waste, are scientifically demonstrated.

Complainant's Witnesses.

The threatening character of the proposed plan of the Passaic Valley District Sewerage Commissioners was

early appreciated by the people of the State of New York.

On May 11, 1903, the Legislature of New York provided (Laws of 1903, Chap. 339), for the appointment by the Governor of a commission to investigate the threatened pollution of the waters of New York Bay. The duty of this commission was

> "to investigate the alleged contemplated construction of a sewer or sewers in the State of New Jersey and the discharge therefrom of sewage into the waters of New York Bay" (Vol. 4, p. 3129).

The Commission was known as the New York Bay Pollution Commission, and consisted of the following members: Dr. Daniel Lewis; Professor Olin H. Landreth; Dr. George A. Soper, Louis L. Tribus, and Dr. Myron S. Falk (*Id.* p. 3119).

The Commission made exhaustive studies into the tidal conditions of New York Harbor, including the paths both of the ebb and flood tides and the peculiar action of the tidal currents, known as the phenomenon of the underrun, the present pollution of New York harbor, the capacity of the water of the harbor to digest sewage and many other facts of importance in determining the effect of the proposed discharge of this Passaic Valley sewage into the New York harbor waters.

The exhaustive report of this Commission, transmitted to the Governor on March 31, 1905, is found in the record (Vol. 4, p. 3057). An excellent map accompanies this report (p. 3057), showing the Passaic Valley Sewerage District and the proposed outlet of the trunk sewer in its relation to the surrounding territory. In concluding its report the Commission recommended the organization of a Metropolitan District Sewerage Commission which should continue the investigations as to the pollution of the harbor waters, and which should be empowered to cooperate with a similar Commission to be appointed by the

State of New Jersey in order that the two states should seek together a final solution of the problem of sewage disposal.

In its conclusions and recommendations based upon its researches and the experiences of other localities, the Commission said (p. 3074):

> "1. It unhesitatingly protests against the consummation of the present plan of construction as outlined by the Passaic Valley District Sewerage Commission.
>
> • • • • • • • • • •
>
> "3. That the Attorney-General of the State of New York be authorized and directed to bring an action in the Supreme Court of the United States against the State of New Jersey and the Passaic Valley District Sewerage Commission, upon his attention being called to any act of said State of New Jersey, or said sewerage commission, towards carrying into effect the construction of said proposed sewerage system."

The Commission made a further report on April 30, 1906, which contained the results of additional investigations by Commissioner George A. Soper into the chemical and bacteriological analyses of the waters in New York Bay and vicinity (Vol. 4, p. 3139).

In the same year the legislature of the State of New York adopted the recommendation of this Commission, and passed an act (Laws of 1906 (New York) Chap. 639), to provide for the appointment by the Mayor of New York City of a Metropolitan District Sewerage Commission, which was to continue the work of the New York Bay Pollution Commission and to "make further investigations into the present and probable future sanitary condition of the waters of New York Bay, and other bodies of water within or adjacent to the several boroughs of New York City and its neighboring districts"; to consider and investigate the present conditions and the future needs for

sewerage and sewage disposal in New York City and in the adjoining municipalities and neighboring districts and "to cooperate with any duly authorized body or commission having similar authority from the State of New Jersey in the joint investigation and consideration of the various subjects specified" in the Act.

The Metropolitan Sewerage Commission was thereupon organized and at the time of its first report of April 30, 1910, was composed of the following members: George A. Soper, James H. Fuertes, H. deB. Parsons, Charles Sooysmith and Lindsey R. Williams. During the period from 1906 to 1910, this Commission continued the work of the New York Bay Pollution Commission and made further careful investigations into the present and probable future sanitary conditions of the harbor waters of New York. Extensive analytical studies were made by the Commission to show the conditions of assimilation of sewage by the harbor waters under various circumstances. These studies included over five thousand (5,000) analyses of water or solid deposits. Samples from all parts of the harbor were examined chemically, bacteriologically and microscopically. All stages of tide and all seasons of year were represented in the results. A theoretical and practical investigation of the tidal phenomena of New York harbor was carried on in cooperation with the United States Coast and Geodetic Survey. The results of this investigation are found in the Commission's report to the Governor of April 30, 1910, (Complainants' Ex. 143, Vol. 3, p. 1772; Stipulation p. 165).

It was pointed out that "at the instance of this Commission, and in accordance with the legislative Act which provided for its creation, an invitation was sent in 1908 by the Secretary of State of New York to the Governor of New Jersey inviting New Jersey to cooperate in the work which the Metropolitan Sewerage Commission of

New York was performing, but this invitation was without result." (Page 43, Report of April 30, 1910.)

The Commission reached the conclusion that the stipulation between the United States Government and the Passaic Valley Sewerage Commissioners was inadequate to protect the interests of the communities bordering on the harbor of New York, saying:

> "The agreement entered into in 1910 between the United States Government and the Passaic Valley Sewerage Commissioners contains provisions inimical to the interests of the City of New York and the other cities bordering on New York harbor in New York State as well as in New Jersey and it is recommended that the State of New York continue to press the suit, from which the United States Government has withdrawn, against the State of New Jersey and the Passaic Valley Sewerage Commission, and that the City of New York apply to the Supreme Court of the United States for permission to intervene and become a party to this suit to the end that proper provision may be made to protect the public interests and the health and welfare of the population of the entire metropolitan district." (Page 47, Report of April 30, 1910.)

As to the results of the proposed Passaic Valley sewerage plan, the Commission reported as follows (p. 329):

> "The sewage as it will reach the pumping station, south of Newark, will be stale. Substantially all the floating solids excepting the resistant ones, such as sticks and corks, will be ground up and practically reduced to a state of solution during the long time required for passage through the sewer. It is probable that but a very small percentage of the decomposable matters in the sewage will be arrested by the screens before discharge into the harbor. Although there may be relatively few visible particles in the discharged sewage, the organic matter therein will be in a putrefying condition, and will

have great avidity for the already deficient supply of oxygen in the harbor water.

It has been contended that the sewage which it is proposed to discharge into New York harbor through the Passaic valley sewer already reaches these waters by its passage through Newark Bay and Kill van Kull. It must be remembered, however, that before the New Jersey sewage can reach New York harbor under present conditions it will have been exposed to the influences of subsidence, bacterial decomposition, oxidation and dispersion. By the time it reaches the Upper bay it is much changed and in a greatly diluted condition. The Passaic valley plan is to discharge the sewage in a crude state, though freed from visible suspended matters, into the center of the Upper bay, thereby relieving Newark bay at the expense of New York harbor. The waters of the Upper bay and the Hudson river are at present heavily charged with sewage; they contain on ebb tides about sixty-five per cent and on the average of ebb and flood tides about seventy-one per cent of the amount of dissolved oxygen necessary for saturation.

Further reports by this Commission were made from time to time. (Complainants' Exhibits 145-149, 200-204; Vol. 5, pp. 4213-4255; 4447-4573). In its report of May 23, 1910, the Commission again referred to the Passaic Valley Sewerage Project and said (*Id.*, p. 4215):

"The discharge of so large a quantity of sewage into the harbor in one locality, even though the outlets be scattered over an area of several acres, would almost certainly result in the reduction of the dissolved oxygen at times of imperfect dispersion, and during times when the currents would be stationary or recently reversed, to so low a point as to invite putrefaction and the consequent evolution of foul odors from the water and sewage mixture. In this connection it should be remembered that the point of outfall would be in the land-locked part of the harbor, within sight of the most densely crowded

business section of New York City, within a distance of one mile of the Borough of Richmond and three miles of the Borough of Brooklyn."

These reports of the New York Bay Pollution Commission and of the Metropolitan Sewerage Commission were based upon most intricate and exhaustive studies by careful biologists, biochemists, bacteriologists and other specialists. The record in this case contains the testimony of a number of these specialists, giving in detail the experiments and researches made by them in order to determine the facts upon which the two commissions based their conclusions and recommendations. We do not propose to review the testimony of these specialists or to give a detailed account of the results of these investigations, which have made possible the accurate knowledge of the distinguished scientists who gave their opinions in behalf of complainants, as to the effect of the proposed Passaic Valley Sewerage project on the harbor waters of New York. Nor do we intend to review in detail the testimony of the representatives of the various civic bodies, the Merchants Association of New York, the Chamber of Commerce, the Municipal Art Commission and other organizations, who after careful study into the proposed plan of the Passaic Valley Sewerage Commissioners, unhesitatingly condemned it as inimical to the interests of the State of New York. For in addition to such testimony, there will be found in the record the testimony of a large number of scientists and sanitary engineers of international reputation, who were unanimously of the opinion that the proposed discharge of the enormous quantity of sewage in the upper Bay of New York would cause a serious nuisance to the People of this State. Without going into all of the considerations which influenced these scientists in the formation of their opinions, we give below the following extracts from their testimony, which, we submit, show be-

yond question that the execution of the plans of the Passaic Valley Sewerage Commissioners will produce a nuisance in the harbor waters of New York and that the construction and operation of a plant in the Newark Meadows such as is described in the stipulation between the Sewerage Commissioners and the U. S. Government will be wholly ineffectual to prevent the creation of this nuisance and its serious consequences.

One of the members of the New York Bay Pollution Commission and of the Metropolitan Commission who testified was Dr. George A. Soper, who as member of both Commissions and as President of the Metropolitan Commission, was intimately acquainted with harbor conditions and the Passaic Valley project.

He testified that he found a serious error in the assumption of the Passaic Valley engineers that the sewage proposed to be discharged into New York Bay would become diffused and transported to sea without producing objectionable consequences (Vol. 1, page 433). He said (p. 434):

> " * * * our studies of the diffusion of salt and fresh water in the bay led to the opinion that an intermittent thorough mixing of the Passaic Valley sewage with the water could not be expected to occur promptly, and that the backward and forward oscillations of the tide would carry sewage sometimes to the very opposite direction from the ocean. It seemed that we should have to reject the idea that the sewage would be promptly carried to sea and consider only whether it could be assimilated or digested by the water of the Bay and rivers in the vicinity of New York. In that connection my opinion was that the digestive capacity of the harbor was very great, larger than would probably be necessary for the assimilation of the sewage which would probably need to be discharged

into it for many years to come. But this conclusion was not based on the assumption that sewage would be brought to the bay from communities remote from the shores of the bay, nor upon exceptional conditions, such as the discharge of a very large quantity of sewage at any particular point. I considered that such conditions, if not prevented, might easily lead to local nuisances, and after charging the water with organic matter which could only putrefy and lead to objectionable conditions. The location of the proposed outlet seemed to me to be very objectionable as being close to a densely populated city. I believe that if the conditions in Boston Harbor would be taken as an indication of what might happen in New York Bay, the discharge of the Passaic Valley sewage might ultimately lead to the discoloration of about three thousand acres or 4.7 square miles of the surface of the water at certain times. This local discoloration with the possibility of the creation of offensive odors directly in the path of ferryboats, excursion steamers and the Atlantic shipping, would in my judgment, be a cause of serious annoyance. The point selected was close to the boundary line, was on the edge, in fact, of the main ship channel, where the ferryboats and excursion steamers and the Atlantic shipping chiefly passed.

As to the effect on health, I found that the proposed outfall was within half a mile of the pierhead line, and a mile and a quarter of the line of solid filling established by the United States Government on the New Jersey shore within two miles of Staten Island and of Liberty Island, a popular point for tourists and other visitors to New York. And of Governors Island, the headquarters of the United States Army in the Eastern District. The Brooklyn shore was about two miles away. Ellis Island, the headquarters of the United States Immigration Bureau, was within two and one-half miles. The southern end of Manhattan was about three and one-quarter miles away."

Another member of the New York Bay Pollution Commission, and at one time a member of the Metropolitan Sewerage Commission, was Professor Olin H. Landreth, connected with the Engineering School of Union College, who for sixteen years had made a study of New York harbor conditions. As to the result of the discharge of the Passaic Valley sewage at the outfall at Robbins Reef, Professor Landreth came to the following conclusion (Vol. 3, pp. 2072-2075):

> "In the first place, and perhaps least serious of all, the artistic beauty of the waters of New York Harbor, which is the gateway of immigration and of a large portion of foreign travel to this continent, will be seriously impaired. Every incoming and outgoing steamship will pass through this sewage field, which will be produced. Will pass through the disposal area which is proposed to be used by the Passaic Valley Sewer Commission. And on that point alone of the beauty of the waters, they are of value not only to the foreign travel and coastwise travel, but largely, and perhaps in greater degree to the residential population." * * *
>
> "Next to the matter of the appearance of the waters comes the question of odors. The point of the discharge of the Passaic Valley Sewer is just such a place as that there will be several miles of swing for the tide on the ebb and flood before the sewage discharge can disperse laterally. It is confined to a fairly narrow channel, and whether it is on the ebb or on the flood, it is confined to an area so small that, in my belief, odors at many times, especially during warm temperatures, will be given off from the sewage. Some from the fresh sewage, but most of all from the septic or stale sewage, or the sewage sludge rather, which rests on the bottom. Not only will the odors come from the waters, but from the shores which are exposed during low tide. The range of tide is about four feet on the average, and four feet of vertical dif-

ference of level of the waters uncover many, many square feet of area of shore territory, and since those shore areas or zones will receive their quota of deposits, it follows that those deposits will be uncovered at low tide.

"Next in order I mention the reduction of oxygen in harbor waters. The reduction of the oxygen content in the waters. It is already impaired and is being impaired progressively, and it will still further be suddenly impaired to a great extent when this sewer begins to be operated, by reason of the difference in the place of disposal of the sewage, from the Passaic River to New York Bay. The reduction of the oxygen will have a serious effect in several ways. In the first instance it will injuriously impair the capacity of the waters to dispose of industrial organic matter, in an aerobic and harmless condition. In just so far as the waters can treat the organic matter in an aerobic condition, the results are comparatively, as compared to the anaerobic conditions, comparatively harmless. The measure with which waters may do that depends largely, if not essentially on their content of oxygen on the percentage of saturation of oxygen which the waters carry. The discharge of this sewage at this point, stale sewage, sewage which has been a number of hours of age when it reaches the disposal area will very rapidly decrease the amount of available oxygen by the oxidation of the septic and stale sewage thus discharged at this point. The reduction of the oxygen also will do harm to animal life. Animal life of almost every grade from the line of demarcation with the vegetable up to the grosser forms of visible fish life are dependent for oxygen on the supply which they receive from the waters. If this supply is impaired, the animal life is disturbed and the balance between the animal life and vegetable life is disturbed and that balance in any waters constitutes an important safeguard to the permanency and stability of those waters. If we in any way disturb one we disturb the other, and in a harmful manner.

"Not only will the oxygen be reduced, but the turbidity will be increased. The water will be less clear, less sparkling than at present. It will be less transparent, and the result of that will not only be of an esthetic nature, but also of a biological nature. The life in the water is affected by the light which enters it in a very sensitive degree. If the water is made turbid then the sunlight cannot enter, or it enters to a lesser extent, and the increased discharge of sewage at the lower portion of New York Bay will tend, in the manner which I have already explained this morning to increase very materially the turbidity of those waters and thus deprive the waters of sunlight as well as to impair their esthetic appearance and their clarity.

"Another result which will flow from the construction and discharge from this sewer, will be the impairment of the bathing beaches and bathing houses. They are already on the verge of danger."

* * *

"I have mentioned already the element of the impairment of the oxygen as affecting animal life. A portion of that animal life will be of industrial value. That is the fish life, and to some extent also shell fish life, and the impairment of the oxygen will, in addition to making the water foul, tend to drive away fish life from the waters. It will also have a very direct and harmful influence on the shell fish life, not only by impairing the conditions under which that life grows, exists, but also rendering the use of shell fish taken from waters so polluted, still more dangerous than they are at present."

Andrew J. Provost, Jr., Consulting Engineer and member of the Metropolitan Sewerage Commission, after twenty years' experience in connection with the harbor waters of New York, testified (Vol. 3, p. 2193):

"From my observations carried on over the period of time mentioned, I have formed the opinion

that the waters of New York Harbor are continually, constantly becoming more polluted, and that from the present state of the waters, as I have noted, I believe that the discharge of large quantities of sewage, such as is represented to be discharged as proposed from the Passaic Valley Trunk Sewer, under the conditions as they have been stated, and from my observations of somewhat similar discharges in the City of Boston and other places that such discharge would constitute a nuisance in the Harbor of New York."

Extracts from the testimony of other distinguished scientists and sanitary engineers, not members of either of the above mentioned commissions, but who were exceptionally equipped with knowledge both as to harbor conditions and the Passaic Valley project are as follows:

Emil Kuichling, Sanitary and Hydraulic Engineer, with vast experience (Vol. 2, pp. 1241-1247), after two years of continuous study and investigation of New York harbor conditions and of the Passaic Valley sewage project, testified:

" * * * it is my opinion that the operation of the Passaic Valley Trunk Sewer, as proposed by the Commission, will result in the creation of a nuisance in the vicinity of Robbins Reef Light, and that the same will be perceived in the warm season not only by people on vessels, but also by the people residing on the shores of the Upper Bay from the Narrows to Governor's Island, and probably also beyond these limits at times. (*Id.* p. 1323) * * *

It is also highly probable that the size of the sewage 'field' will increase in more than linear ratio to the rate of discharge, so that the great volume proposed to be discharged daily at Robbins Reef Light will doubtless extend over the entire distance traveled by the tidal currents. As previously stated, the flood current in the Upper Bay will carry a float about eight miles northerly, while the ebb current will transport it about 10 miles southerly from

Robbins Reef; hence it can be inferred that in conjunction with the eddying lateral currents and a strong wind, the entire surface of the bay will frequently be polluted with this particular sewage, even if all the other tributary outlet sewers were permanently closed. It is likewise certain that in comparatively calm weather the lateral drifts already described will bring more or less polluted water and particles of sewage from the proposed outlet to the shores of Jersey City, Bayonne, Richmond (Staten Island) and Brooklyn. In sheltered coves such matter will accumulate and form offensive deposits" (p. 1320).

Harrison P. Eddy, consulting engineer, specialist in hydraulic and sewerage work, with offices and assistants in Boston and Chicago, a graduate of chemistry, science and engineering, Worcester Polytechnic Institute, after many tours of inspection of the waters of New York Bay and in the Passaic Valley region, and also after studies of the plans and specifications of the Passaic Valley Sewerage Commission, came to the following conclusion (Vol. 2, pp. 1471-1472):

"Taking into consideration the quantity and character of the sewage which will be discharged at Robbins Reef, if the Passaic project is carried on to completion, and taking into consideration also the method of dispersion proposed it is reasonable to expect the following results:

The water in the immediate vicinity of the outlets will at times contain floating sewage matters which can be readily recognized as such.

Small particles of grease will be seen floating or suspended upon or in the water.

There will be oily sleek upon the surface of the water, which will cover large areas and will be traceable for long distances from the outlets. At times coloring matters, originating in industrial wastes, will cause a discoloration of the waters in the neighborhood of the outlets, and this discolora-

tion will cover large areas and be traceable for long distances.

If by any chance the sewage is discharged in a relatively fresh condition, it will cause an increase in turbidity and give to the water a milky and dirty appearance.

During the warm weather the sewage will have undergone decomposition to such an extent that it will be dark colored and give to the water a dark appearance.

At practically all times the sewage will add materially to the quantity of finely-divided suspended matter and increase the turbidity.

The sewage will at times, especially in hot weather, contain large quantities of suspended matter some of which will be relatively coarse and will be recognizable as of sewage origin. This suspended matter will be deposited at various points in the harbor where the velocity is relatively low and will consume oxygen from the overlying water.

The quantity of organic matter in the sewage discharged from these outlets will be very great and will cause a rapid diminution in the supply of dissolved oxygen in the waters of the harbor.

At times of storm the sewage will contain large quantities of detritus from the streets. This matter will be carried through the sedimentation basins and will be discharged with the effluent in quantities up to the capacity of the intercepting sewer, which will be 18 million gallons per hour. This immense quantity of sewage will find its way to the surface of the harbor water, and will cause the discoloration of large areas of the harbor, giving to the water a dirty muddy appearance. This condition will result after summer showers when the water may be used for pleasure purposes, and will constitute a condition which will be highly objectionable to persons using the harbor for recreation purposes. The muddy water thus discharged will undoubtedly find its way long distances from the outlets, so that its effect will not be wholly local.

The sewage, especially during the warm season

of the year will have undergone decomposition to such an extent that it will have become putrid and will give rise to highly offensive odors.

This sewage will rise to the surface of the harbor water and at times will give off into the overlying atmosphere a portion of the odors which it contains. It may therefore be confidently expected that offensive odors will be noticed in the vicinity of the outlets, and, under conditions which cause the sewage to stream toward Staten Island and toward Manhattan, odors may at times be observed which can be attributed to this sewage."

See also the witness Eddy's conclusion (*Id.*, p. 1457).

Desmond Fitzgerald, a distinguished sanitary engineer, a member of the corporation of the Institute of Technology at Boston and a former President of the American Society of Civil Engineers, came to the following conclusion (Vol. 2, pp. 1541-1542, 1575):

"I am of the opinion that this amount of filth (the Passaic report described the capacity of the sewer as made up of 'sewage and other polluting matter') discharged practically at one spot in the Upper Bay will create a local and general nuisance.

This amount of sewage concentrated in the neighborhood of Robbins Reef will create a local nuisance which in a few hours under the action of the winds and currents will be carried to any of the surrounding shores—thus producing a long series of general nuisances in every part of the harbor—which prospectively will increase in intensity as the sewage becomes less diluted and the dissolved oxygen in the Upper Bay is carried lower and lower.

These nuisances, in my opinion, will result in a substantial injury to the Harbor of New York and to its waters in connection with the uses for which they are now and always will be extremely valuable.

* * * * * * *

The effect of the discharge of this proposed sewage at Robbins Reef will be to inject into the harbor,

the Upper Bay at Robbins Reef, or near Robbins Reef, a very large mass of sewage, in very bad condition, which will be very highly polluted, which will seize oxygen with great avidity, which will lower the percentage of oxygen. To what extent, it is impossible for me to now state. But it will lower it materially in my judgment all around the borders of the Upper Bay, and extending beyond those borders up the Hudson River and to certain distances into all the inland waters connected with that harbor. The fact that that sewage will contain a large amount of turbid material, which will be in a condition to produce a bad effect upon water, and that the liquid and colloids will also be highly putrescible. I believe that the effect of the discharge of such a very large mass of sewage will be very detrimental and will be felt a great distance, depending largely on local conditions."

Professor Earle B. Phelps, consulting sanitary engineer, Professor of Public Health, Massachusetts Institute of Technology, bacteriologist and chemist, chief biochemist, Hygienic Laboratory, United States Public Health Service, after several years of direct scientific work on New York Harbor waters, its hydrography, bacterial and oxygen content, etc., came to the following conclusion (Vol. 2, pp. 1617-1618):

"The discharge contemplated at this proposed Passaic Valley Sewer will, in my opinion, immediately increase the present evidence of pollution in New York Harbor and reduce the capacity of the harbor to receive and dispose of sewage. By the methods that I have already indicated I have computed the probable effect of this discharge upon the Hudson River.

"The location of the outlet with respect to the channel will, in my opinion, cause the major part of the flow to go due north into the Hudson River during flood tides. From a consideration of the tidal volumes and of the tidal prism in the Hudson,

I estimate that for six hours out of every thirteen the entire flow of this sewer will go into the Hudson River. The prism between the Battery and 96th Street at the end of the flood is made up wholly of water that has passed directly over Robbins Reef. One-third of this water has passed over the reef three times, and 10 per cent. of it has passed that point five times. This illustrates the accumulating effect of the tidal oscillation by which the direct effect of the sewage discharge is magnified in these tidal estuaries. The Upper Bay is a great mixing basin for all the waters which enter and leave it. It is not possible to state definitely how complete this mixing is. In the absence of any such statement it is not possible to exactly determine the extent of this accumulating action of the tides. I have calculated it, however, upon two extreme assumptions between which the real truth must lie. I assume a complete mixing at each tide and we may assume no mixing whatever. In the first case, the sewage of the Passaic Valley Sewer will, in 1940, have a dilution in the Hudson River, between the Battery and 96th Street, at the end of the flood tide, equivalent to only six times the dilution that exists there today; or, in other words, the extent of the additional pollution will be 16 per cent. of the present pollution. On the opposite hypothesis and under similar conditions the corresponding value is 8 per cent. Therefore, it may be stated with every degree of fitness that the existing state of pollution in the Hudson River will be increased by this proposed discharge by an amount between 8 and 16 per cent. of its present amount. This means that the capacity of the Hudson River, which is the weakest point in the entire system, will have been reduced to a dangerous extent. Instead of conserving the waters of this great center of population the proposed sewer project will actually throw an additional burden upon the already overloaded waters of the Lower Hudson. • • • In my opinion this question of putrescible organic matter and of the oxygen relations of the stream is of far more import-

> ance than any of the criteria which have been suggested in the stipulations with the Federal Government. These refer to visible suspended matter, to the appearance of the water, and to the odors. The sewage as it is discharged may be conceived to produce none of these effects, and yet may rob the lower Hudson River of the oxygen which is absolutely essential to its well being" (Vol. 2, p. 1618).

We regret that in order to make this brief of reasonable length, it is impossible for us to quote at greater length from the testimony of Professor Phelps, both on direct and cross-examination. In the year 1910, Professor Phelps was employed by the Board of Estimate of New York City to give a year of his time chiefly to the problem of determining the capacity of New York harbor to receive and dispose of sewage. The ability of the harbor to assimilate the additional sewage proposed is the principal question to be decided by this Court. Professor Phelps' conclusion that

> "the capacity of the harbor waters to receive and digest sewage was rapidly being approached (1911) if it had not already been reached,"

is completely established by the experiments and researches detailed in his testimony (Vol. 2, pp. 1597-1640).

Professor Charles-Edward Amory Winslow, Associate Professor of Biology, College of the City of New York, curator of Public Health, Museum of Natural History, and lecturer on municipal sanitation at Columbia University, after two years of continuous study and scientific investigations of New York Harbor conditions, came to the following conclusion (Vol. 2, pp. 1651-1653):

> "In view of all these facts I am inclined to think that at times of slack water the sewage from the Passaic Valley Sewer will often be visible at or near the disposal area as a turbid lake of dark and more or less septic sewage, in sharp contrast to the clearer

waters of the harbor. Fine particles of suspended matter will at such times be distinctly visible. When sewage comes into contact with salt water there is a precipitation of fine colloidal matter which greatly adds to the visible pollution and grease balls of various sizes are likely to form as the grease is coagulated by the cooler waters of the harbor. Industrial wastes may at times produce still more marked discoloration.

"Under certain conditions these offensive appearances will be reenforced by odors of putrefaction from the highly septic sewage discharged under unfavorable atmospheric conditions, such as humidity and slight wind movement, especially at times of slack water, foul and objectionable odors will, in my opinion, be detected in the vicinity of the disposal area and possibly for some distance from it."

* * * * * * * * *

"The direct effect of the sewage would, of course, be limited to the transfer by currents of unpurified sewage to other regions. Floating fields of sewage often retain their identity while carried by currents for considerable distances in the absence of strong wind action."

* * * * * * * *

"A second direct effect of the Passaic Valley sewage upon the more remote regions of the harbor will be due to the deposition of suspended organic matter. It has been noted that the sedimentation tanks proposed will not remove more than one-third of the total suspended solids. Considerable amounts of the remaining suspended matter, including the most putrescible and offensive portion, will be discharged into the harbor and will settle out as soon as it is carried by currents to points where the velocity is less than five-tenths inch per second. Such deposits may cause a local nuisance through the formation of putrescible accumulations of organic sludge.

"The disease bacteria discharged from the Passaic Valley sewer will persist for a time in the

harbor and some of them will be carried to considerable distances, so as to increase the danger which now threatens those who bathe in the harbor or eat shell-fish taken from it. The upper harbor is at present so much polluted from other sources as to be unsafe for such uses even now. The shores of Staten Island and Long Island on the Lower Bay beyond the Narrows are still, however, in reasonably good condition, and the discharge of a large volume of sewage at Robbins Reef will constitute a possible menace to the bathing beaches on Staten Island and Coney Island, and to the shellfish beds on the southeast shore of Staten Island.

"These are the principal direct effects from the Passaic Valley sewage on other regions of the harbor. It will also exert an indirect effect on all parts of the harbor by the consumption of dissolved oxygen from the incoming tidal waters. It has been made clear by recent studies that the reabsorption of oxygen from the surface of a body of water is comparatively slow unless heavy winds are blowing, and compared with the pollution which enters New York Harbor this factor is almost negligible. The oxygen which makes possible the assimilation of sewage in the Upper Bay is mainly that which enters through the Narrows and at Throggs Neck and from the Hudson River above, the principal fraction of the total amount being that which enters through the Narrows. The Passaic Valley Sewer outlet is situated just at the strategic point where it will tend to cut off the supply of oxygen which naturally enters through the Narrows and makes possible the maintenance of bearable conditions in the lower reaches of the East River and the Hudson. Even now, with 75 per cent of the oxygen necessary for saturation present in the waters of the Upper Bay, the percentage of saturation in the East River and the Hudson falls to 55 per cent. If the main source of purifying oxygen for the whole harbor is diminished by the discharge of sewage into the main channel of the Upper Bay, the amount available for the waters adjacent to Manhattan will be correspondingly diminished;

certain regions will become polluted beyond the critical point, and grave nuisances may follow even at remote points as the indirect result of the Passaic Valley sewage discharge."

John W. Alvord, of Chicago, Illinois, Consulting Engineer to the Illinois & Michigan Canal Commissioners, former president of the Illinois Society of Engineers and Surveyors, author of a number of papers on sewage disposal and relative sanitary subjects, testified (Vol. 3, p. 1872):

"Q. From all these studies and matters also that you have taken into your consideration, what would you expect to be the result of the discharge of the Passaic Valley sewage through the Passaic Valley Trunk Sewer at the outfall at Robbins Reef? A. I would expect that it would have a serious effect in abstracting further the oxygen from the waters of New York Harbor. Experience has shown that where waters are nearly laden up to their limits, slight additions become apparent in the most unexpected manner. * * * I would expect to see visible floating matter, sleek, greasy colored fields, apparently well defined under some conditions from this outlet, and more diffused under other conditions, and I would expect that there would be nuisances increasing with the population under such conditions.

"Q. Is the transition stage from a condition that is tolerable in sewage laden waters to one that is unbearable sudden, or slow? A. So far as my experience goes it is comparatively sudden. There is a long period preparatory in which the collection of sludge on the bottom, in which the growth of slight discoloration is not usually found unbearable, but there comes a time when the last increment of polluting matter is added which the waters will digest and immediately at that time there flashes up a condition of odor and nuisance and other intolerable conditions which cause the nuisance to become unbearable.

"Q. From your familiarity with the waters of New York Harbor, and particularly the waters of New York Upper Bay, do you think that there is a large or a small margin of digestive capacity left for the riparian communities as to sewage digestion? A. It is my opinion that the margin left is now exceedingly small."

Robert Spurr Weston, of Boston, Massachusetts, Consulting Sanitary Engineer, after nine months of continuous study of conditions of New York Harbor waters and specifications of the Passaic Valley Sewerage Commission, came to the following conclusion (Vol. 3, pp. 1951-1953):

"The primary effect of the discharge of sewage assuming the data mentioned in your question, and also assuming that the discharge of sewage would be substantially as outlined in the first published report of the Passaic Valley Sewerage Commission, would be the creation of a stinking area in the vicinity of the Robbins Reef Light House. There are, however, important other effects.

"The character of the sewage proposed to be discharged by the Passaic Valley project has been discussed before, and it is my opinion that not only would it be offensive and disagreeable in appearance, but would contain germs, which, if allowed access to human beings or their food, or if carried to shell-fish beds by the tide or wind, would cause such diseases as typhoid fever and other intestinal disturbances. What is true of oysters, clams and other shell-fish would be also true of other food to which the water might have access.

"The deficiency of dissolved oxygen has already caused some reduction in the major fish life of the harbor, and further depletion by the introduction of a large volume of septic sewage would effect a still further reduction, probably driving away certain species now inhabiting the waters of the Bay.

"Effect on painted wood and metal: If the dissolved oxygen were completely exhausted, as would

be the case in the sewage itself, hydrogen sulphide would be evolved, which would cause certain paints used to coat wood and iron work to darken in color. This effect has been observed in other rivers and harbors where the dissolved oxygen has been exhausted, notably in the lower Passaic, the Blackstone in Massachusetts, and the inner harbor of Baltimore before the installation of the present sewerage system."

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"As shown by numerous float observations as well as by a study of the appearance of the Bay, sewage discharged at Robbins Reef will not remain in that vicinity any material length of time, but it will be carried by the tidal and other currents north, at times well into the Hudson River and northeasterly at times well into the East River. With a reversal of the tide this sewage will be carried down the bay and through the Narrows into the Lower Bay, where it will remain and accumulate until a reversal of the tide, when it will be carried back into the Upper Bay. It has been pointed out that such sewage fields as may form will also be driven by the wind to the shores of the Borough of Brooklyn and the Borough of Richmond. Such fields and the general increase in the quantity of sewage in the waters of the bay will cause the accumulation of grease and filth about the wharves and docks and upon the shores of the city."

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"The general effect would be to transfer the disposal of the sewage and all the disagreeable accompaniments thereof from the waters of the lower Passaic River and Newark Bay to those of New York Bay and its tributaries. Furthermore, the volume of sewage now entering the Bay in a purified condition through the Kill van Kull, will be increased by that which now passes around Staten Island through the Arthur Kill. Not only must the Bay dispose of more sewage than at present, but

sewage in a semi-putrefied and offensive condition. The result would be that the waters of the Upper Bay would be changed for the worse and to a highly objectionable degree.

"Effect on commerce: If the Passaic Valley project be carried out, the sewage field would extend across the main channel of the harbor. Incoming and outgoing vessels would pass through this field, except when affected by very unusual wind and tidal conditions. The turbidity, grease and other matter would make the waters of the Upper Bay unpleasant for commerce and tend to make excursions on the harbor unpopular, thereby creating noticeably disagreeable conditions in the largest port of the country, consequently lessening its prestige and depreciating the value of the Bay for recreation purposes.

"If the polluted harbor water were used for washing decks, and in the pantries and galleys of ships, it would be liable to come into contact with food used by human beings and thereby become a possible source of infection."

Professor William P. Mason, Professor of Chemistry at the Renssalaer-Polytechnic Institute at Troy, member of a number of scientific bodies both in this country and abroad, and president of the Hygienic Session of the International Congress of Applied Chemistry, after making a special study of the condition of the harbor waters of New York, said (Vol. 3, p. 2006):

> "In my opinion the water of New York Bay will be seriously damaged by the pouring therein of the proposed volume of sewage in the manner proposed. * * * It will be unduly damaged, the bay water will be. Its pollution which is now great will be made greater and the time will come when that pollution growing from all sources will produce a bay-wide nuisance."

Professor William T. Sedgwick, Professor of Biology and Public Health in the Massachusetts Institute of

Technology, for eight years Biologist of the State Board of Health of Massachusetts, and Director of the Sanitary Research Laboratory and Sewage Experiment Station, Massachusetts Institute of Technology, since 1902, author of a number of works on sanitary science and kindred subjects, and having an honorary degree of Doctor of Science, Yale University, came to the following conclusion (Vol. 3, pp. 2256-2259):

> "I do consider the proposed discharge highly objectionable and contrary to the public health, interest and welfare because, in the first place, such a system of disposal runs counter to the spirit of modern sanitary science, since it proposes to foul still further a body of water already too much polluted, and thus violates the first principle of public health conservation, namely, cleanliness."
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> "Instead therefore of adding to the already too extensive pollutions of New York Bay the State of New Jersey ought in my opinion rather to join hands with the State of New York and set to work immediately to prevent all further pollution to the end that these precious bodies of water shall be reserved forever for the real comfort, safety, convenience, and sanitary welfare of the vast populations which will soon surround them."
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> "Now the effluent discharged from the dispersions area of the Passaic Valley sewer will in my opinion generally be of a higher temperature than that of the water of the bay in the immediate vicinity, and will, therefore, and for other reasons tend to rise and spread out over the surface, making a polluted, evil smelling, foul, and unsightly surface, rendering life uncomfortable and unpleasant to those living in its near vicinity or passing over it while engaged in commerce, travel and pleasure, and will constitute a nuisance, to the detriment and

injury of commerce, navigation, and the public health, comfort and convenience.

"I believe that the construction and operation of the proposed Passaic Valley sewer will discharge large quantities of putrid matter into the waters of New York harbor, which matter will oscillate back and forth through the Narrows and through the channels of both upper and lower New York bays, and will tend in part to settle, make deposits and eventually shoal and obstruct navigation in those waters clogging the navigable channels and necessitating the expenditure of further sums of money in maintaining those channels, for example, by the maintenance of dredges, scows and boats to remove said deposits, while the dredges, scows and boats thus required will in themselves obstruct navigation, impede commerce, and diminish the comfort, pleasure and convenience of the people of the State of New York."

Theodore Horton, Consulting and Chief Engineer of the New York State Department of Health, who for two years was engaged in the preparation of the plans for the proposed Passaic Valley Trunk Sewer project came to the following conclusion (Vol. 3, pp. 2298-2299):

"It is my opinion that a local nuisance will be produced in the vicinity of the outlet, and a general nuisance for a considerable distance from the proposed outlet, due to suspended matter, grease and sleek and discoloration, a sewage treated as it is proposed to be treated will cause deposits which will slowly accumulate in many parts of the harbor, more particularly in the vicinity of the outlet. It will deplete the dissolved oxygen and will destroy—will damage the water for shipping, shipping and industrial purposes. It will blacken the paint on vessels and interfere with pleasure uses of the water such as boating and fishing, and will interfere with the fish life. It will endanger health first directly through the bathing beaches, infecting the bathing beaches and floating baths, or through

infections received at these places. It will also affect the fishing and boating and the shell fish pollution. Drift wood which has been gathered in the waters or from the waters which have touched or floated in the waters nearby this pollution, and there will be danger to health from the exposed shores and wharves through the medium of fly transmission. There will be danger from the use of water used for washing boats, where this water is taken from portions of the harbor and bay where the pollution will reach. There will be danger from the dredging operations, which will cause this mud to be brought more into suspension, and sometimes brought out upon the surface, where it may become a source of infection. Indirectly there will be a danger to health due to the depression of the human system and the lowering of vitality or vital resistance of people who are subjected to the odors, or who are in the vicinity of the waters that have been grossly polluted by the sewage. These odors and the general obnoxious appearance and offensive conditions will depress the human system and lower the vital resistance to the attack of disease germs. This is of course a secondary danger or menace to the health."

The distinguished scientists above quoted were no less emphatic concerning the inadequacy of the plant to be erected on the Newark Meadows for the treatment of this sewage than they were as to the serious consequences of the discharge of this sewage into the harbor waters of New York, after having been so treated.

Thus Harrison P. Eddy testified (pp. 1440 and 1441):

"The first step in the project for the partial purification of the sewage of the Passaic Valley will consist of passing the sewage through coarse screens. This is a process in common use and will remove from the sewage only the large coarse matter, which will consist chiefly of paper, pieces of cloth, fruit skins like bits of orange peel, sticks and

such other large substances as may be brought through the sewers.

The second step will be the passage of the sewage through grit chambers, which can be relied upon to remove a portion of the heavy material such as sand, gravel, cinders, ashes, coal, etc.

The third step will consist of passing the sewage through self-cleaning mechanical screens, which will have clear openings of not over .4 of an inch. These screens will correspond, in a general way, to those that are frequently used in sewage purification works for the removal of the coarser floating and suspended matters. They will have slightly smaller clear openings than some of the screens which have been used, but much larger clear spaces than screens ordinarily installed for fine screenings of the sewage. Only relatively coarse matter, such as bits of paper, corks, pieces of cloth, fruit skins, etc., will be removed from the sewage by means of these screens. Large quantities of the more finely divided organic matter, such as particles of grease, small fragments of paper, etc., will pass through these screens.

The fourth step in the process of partial purification will consist of passing the sewage through the sedimentation basins, at a velocity not to exceed .5 inch per second, based upon the average flow, until 1920, and .75 inch per second based upon the maximum rate of flow. These tanks are to be provided with scum boards for retaining any floating matter. The results of sedimentation of the sewage in these tanks will vary greatly from time to time. On the average it is not likely that over 35 per cent of the suspended matter of the sewage will be deposited in the tanks. At times their efficiency may be so high that one-half of the suspended matter will be removed, while at other times it is probable that the removal will not amount to more than 5 or 10 per cent.

This opinion is based upon personal experience in the sedimentation of sewage in tanks somewhat

similar to those proposed in this case. A prolonged series of tests was made in Worcester, Massachusetts, with a large horizontal flow tank, the velocity of flow ranging in different experiments, from 8 feet per hour to 27.8 feet per hour. The velocity in the proposed Passaic tanks will range from 150 to 225 feet per hour. The results of the Worcester experiments at the very low velocities mentioned range from 31.7 per cent to 66.3 per cent removal of suspended matter, the average being about 48 per cent removal. (See Tables 15 and 16.)

Beginning in September, 1908, a large proportion of the sewage of the City of Worcester was passed through one of the sedimentation basins before being discharged onto the sand filter beds. The velocity of flow through the basin during this period was 333 feet per hour. The monthly efficiency of sedimentation varied greatly, the maximum being 56.6 per cent while, during several months, the average efficiency was below 30 per cent.

The tanks at Worcester, used for the sedimentation of sewage, were equipped with efficient scum boards, and there is no reason to expect any better results from the Passaic Valley tanks than were obtained with these.

Relatively large quantities of visible suspended matter escaped with the effluent from the Worcester tanks, and this will undoubtedly be true in the case of the Passaic Valley purification works. Furthermore, at seasons of the year when fermentation of the sludge is active, gas is formed in large quantities in the deposit and from time to time great masses of sludge will be carried to the surface of the tanks by the entrained gasses. At such times large quantities of sludge are likely to pass over from the tanks with the effluent, and they will ultimately be discharged at Robbins Reef."

Professor Charles-Edward Amory Winslow testified (Vol. 2, p. 1650):

"The condition of the sewage to which I have just referred is one factor of prime importance

which must be considered in estimating the efficiency of the purification works proposed. The length of the trunk sewer makes it certain that the sewage will be stale or septic when it reaches the works, and still more so when it is discharged at Robbins Reef; that the fecal solids will be largely disintegrated so as to pass through screens; and that the liquid will tend to be laden with finely comminuted matter and with a maximum of impurity in solution. These facts seriously limit the effectiveness of screens and sedimentation basins.

Coarse screens with openings of four-tenths of an inch will only remove coarser particles, sticks, rags, orange peel, etc., and will produce little effect on the stability of the effluent. As an outside estimate such screens could not take out more than 5 per cent. of the suspended solids in the sewage. The sedimentation basins with a detention period of one and a half hours and a mean lineal velocity of half an inch per second would in all probability remove not over 30 per cent. of the suspended matter in the sewage and 15 per cent. of the organic matter. In actual practice the improvement would often be considerably less than this, particularly in the summer when decomposition has proceeded farthest, and when the organic matter will be most thoroughly broken up.

Under the most favorable possible conditions, the projected screens and sedimentation basins can only be expected to remove the larger floating particles to diminish the sludge deposited in the harbor by about one-third, and to diminish the putrescible organic matter in the sewage by about one-sixth. Furthermore, this one-sixth will include the most stable portion of the organic matter, while all the most putrescible portions will be discharged in solution and fine suspension."

John W. Alvord testified (Vol. 3, pp. 1864, 1865):

"It is my conviction, from a study and examination of the Passaic Valley community, that the sewage will arrive at these works in a state of advanced

decomposition; that the solids of fecal matter will be disintegrated so as to easily pass both screens provided; that the liquid will already be black, odorous, laden with finely commutated matter, and with a maximum of impurity in solution. Neither of the screens will, therefore, in my opinion, remove more than the floating trash, which always accompanies the flow of large sewers, and which is relatively small in amount. Nor will the tanks receive deposits of more than the coarser and heavier particles during the short check to the velocity of the flowing sewage.

My observations on sewage disposal works have convinced me that it is a prime essential to their success that the sewage be received by them in a comparatively fresh state. When this is the case and with proper design and operation they are uniformly quite successful. When this is not the case they have been locally objectionable and usually inefficient. Where a long intercepting sewer such as here is proposed, some 21 and 2/10 miles in length, must bring the sewage from other systems of sewers, the sewage itself cannot but be in an old decomposed and rotten condition. The solids being finally commutated into suspended matter, which is scarcely visible as well as colloids, which are suspended matter on the verge of translation into impurities in solution. To completely purify such sewage on a large scale successfully is practically impossible at any reasonable cost.

From the testimony given in this case by Mr. Harrison P. Eddy, going into detail as to the length of time taken for the sewage of the various communities to reach the outlet, I note that the sewage will be from 12 5/10 hours old under the most favorable conditions to 18 or more hours old under the least favorable conditions. This determines that the sewage will be such in character that ordinary or usual works for its purification would need to be tremendously expensive, vastly more expensive than works for the treating of fresh sewage. It also means that works for screening and sedimentation

> are less efficient than would be the case with fresh sewage. It is also known that old, stale and refractory sewage of this character is more difficult to filter. Experience upon filter beds denote that it is exceedingly difficult in aerobic filtration to nitrify successfully the effluents from tanks in which sewage has remained for very many hours, corresponding with the age denoted herein. I am, therefore, of the opinion that such works will have the minimum of efficiency either for removing suspended matters or for screening them. A certain amount of trash will undoubtedly be removed by the coarser screenings, but the finer suspended matters will readily pass through the screens called for by this agreement."

Professor William T. Sedgwick testified (Vol. 3, page 2239):

> "My principal objections to it are, first, that it permits the direct transfer of a vast quantity of putrefying liquid to be carried away from its natural purification basin and deposited still more putrid
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> and without purification in the waters of a different sanitary area, to wit, New York Harbor. In the second place, I do not believe that the screening as proposed will remove at all times and under all circumstances materials visible to the naked eye, but that on the contrary, in spite of such screening, these will be carried into New York Bay and be readily visible. Finally, I do not believe that the means contemplated will be adequate to produce the results required. And especially I do not believe that the steps proposed to be taken will prevent either a nuisance or injury to the public health or interference with major fish life in the waters of New York Bay."

We have already shown that the discharge of the Passaic Valley sewage into the harbor waters of New York in the manner proposed by the defendants will have these results: (1) the creation of a large sewage field in

the main ship channel of this harbor, (2) the sewage so discharged will give off highly offensive odors, (3) the sewage fields which will form at the point of discharge will not remain in that locality, but will be driven by the winds and tides to the various shores about the harbor, (4) the discharge of this sewage in the manner proposed will so reduce the oxygen content in the harbor as to intensify the nuisances where they now exist and give rise to nuisances which are not yet in existence, (5) the place of discharge is so situated as to cut off the supply of oxygen in the water coming through the Narrows on the flood tide, which now acts as a refreshing influence upon the lower Hudson, so that as a result the supply of oxygen in the lower Hudson will be so reduced that that river will in a short time resemble the present condition of the Passaic, and (6) the discharge of this sewage will remove such of the major fish life as now exist in the harbor.

The disastrous effect upon the people of New York of these consequences is too plain to require development by any argument. This Court needs no extracts from testimony in order to appreciate the feelings of the citizens of Staten Island, who would be forced twice a day to pass through Passaic Valley sewage fields as they go to and from their places of business in Manhattan. The same also may be said of the passengers on ocean liners who are compelled to pass through sewage fields on entering the greatest port of the United States. Nor need we dwell upon the injuries to property, important as they are, such as destruction of oyster beds, contamination of shellfish, the ruin of bathing beaches, and the other clearly apparent injuries which will follow the creation of this nuisance. The danger which we desire to emphasize is the menace of disease.

We do not deem it necessary to quote at length from the testimony to be found in the record, for the menace

is perfectly apparent. The following extracts from distinguished sanitary engineers and sanitarians are sufficient:

Desmond Fitz Gerald testified (Vol. 2, p. 1589):

> "From the Passaic Valley trunk sewer there will be a great many dangers. In the first place, the danger of contamination of disease to human beings, first by the water being blown on to the faces of persons navigating thereon, and by coming into bodily contact with their systems in using it in different ways, such as washing the boats, etc."

Theodore Horton testified (Vol. 3, p. 2300):

> "In regard to the public health the sewage discharged will contain infectious material which will be carried to distant waters and shores. This infected material will cause danger to health by affecting the bathing beaches, boating and fishing, shell fish, driftwood, dredging operations, and through the medium of flies, that may be on the exposed shores and docks and through the medium of water that may be used for deck and other purposes in ships. A nuisance will be produced at the outlet or elsewhere affecting yachtsmen, ferryboat passengers, fishermen and industrial concerns, which will result from odors, discoloration of the water, suspended and floating matters, sleek and grease, deposits and the blackening of paint."

Nor is this menace to the health of the people of New York limited to typhoid fever and other infectious diseases. The offensive odors which will arise from the vast sewage fields proposed to be created in the Harbor of New York will in and of themselves have a most serious effect upon the health of the people.

Professor William T. Sedgwick, probably the most eminent sanitarian in the country, testified as to the effect of the proposed "disgusting and dangerous odors due to

the gases of putrefacation" as follows (Vol. 3, pp. 2812, 2813):

> "It would, I believe, diminish vital resistance to disease and cause lassitude, loss of sleep, headaches, malaise, and possibly even nausea at times among people living within its reach, that is, within the Metropolitan district."
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> "Sore throats have also been observed to prevail in the vicinity of highly polluted sewage sea waters. Other ailments which have been noticed in such cases are diarrhea, prostrations, headaches, loss of appetite and a general lowering of health with malaise. These conditions prejudicial to the public health appear to be due to what are sometimes called effluvium nuisances; that is to say, bases arising from putrefying mixtures of sewage and water, or to sewage deposits from either or both of which sulphuretted hydrogen and other poisonous gases readily arise. When these deposits are laid bare by the tides if that happens, there is also danger of insect transmission of living micro-organisms from the mud to people in the vicinity. So that, summing it all up, we may say that while it is often difficult to prove any increase in the presence of infectious diseases from exposure to sewage polluted waters, stinking waters or exposed flats, such increase has in fact, in my opinion, reasonably contributed to these causes and constitutional effects are unquestionable, for, as I say, I have myself witnessed and experienced some of them."

The cross examination of the witnesses whose testimony we have quoted merely brought out in bolder relief the testimony given upon the direct. It is true that defendants' counsel did obtain from a number of the witnesses the admission that if the State of New Jersey lived up to certain of the terms of its agreement with the United States Government, which purported to provide that no

nuisance would be created, then no nuisance would be created. This, of course, is merely playing with words. The question of the pollution of the harbor waters of New York becomes merely a lesson in elementary logic. Defendants assume what they wish to prove and then prove it by the assumption. It is not difficult to see that there is no limit to the number of things that can be proved in this manner, and we desire to point out here the entire worthlessness of the admissions obtained by defendants' counsel upon the cross examination. We submit the following extracts from the testimony:

Prof. William T. Sedgwick (Vol. 3, p. 2269):

> "Q. You have spoken of anticipated injuries in New York Bay from the discharge of this effluent, and one of them, as I remember, was the injury to the property of the United States. If the guaranteed results are produced by the effluent discharged into New York Bay, do you think that the contemplated injury will result? A. I think it will, yes.
>
> "Q. Well, I draw your attention to the guaranteed results that being the sixth item, absence of injurious effects from said sewage discharged upon the property of the United States situated in the Harbor of New York? A. Of course, if all injurious effects are avoided, there will be no injurious effect. That is perfectly obvious.
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> "Q. That seems to be an absolutely logical inescapable conclusion? A. I see no escape from that.
>
> "Q. Now, I ask you again that if the effluent discharged into New York Bay produces the guaranteed results, do you mean to say that you think there will be any injury to the property of the United States in the harbor of New York? A. No, logically speaking. Paragraph 6 seems to cover all that point."

Professor Earle B. Phelps (Vol. 2, p. 1638, fol. 2424):

> "Q. Now, Prof. Phelps, assuming that the legal intent of the instrument is that the Passaic Valley

> Sewerage Commissioners agree to produce the results in the effluent which are specified in the stipulations, either through the methods and appliances specifically described in the instrument, or stipulations, or by adopting other methods or appliances or devices for purification of the sewage, then do you say that the discharge contemplated will be injurious to the waters of New York Bay? A. If they discharge an effluent which comes up to the stipulations I believe that effluent will be unobjectionable in the waters of New York Bay."

Here again the witness is asked in effect whether, if it be assumed that no nuisance would be created, any nuisance will be created. (Professor Phelps had already testified that if the effluent from the proposed sewer came up to all the requirements of the stipulation, it would mean "practically perfect purification" (p. 1629). This, he stated, it would be impossible to obtain on account of the expense (p. 1639).

Professor Charles Edward Amory Winslow (Vol. 2, p. 1665, fol. 2463):

> "If the stipulations in regard to the absence of visible suspended particles and the absence of odors due to putrescibility, and the absence of grease or color, *absence of any damage to health, or the creation of any public or private nuisance,* if they were fulfilled in regard to the sewage of New York there could, obviously, be no objection to that discharge, except in regard to the possibility of sludge deposits and injury to fish life."

(p. 1668, fol. 2467):

> "Q. *Assuming* that the stipulation as to the reduction of the dissolved oxygen in the seventh item of this stipulation as to results means that the oxygen will not be reduced by this discharge in the waters of the bay below a point of 70 per cent. in saturation, do you think that the discharge will be

objectionable or injurious to the waters of New York Bay? A. No, I should say not.

(p. 1669, fol. 2468):

"Q. Why did you say the cost of living up to those stipulations would be enormous? A. Because I am familiar with the general cost of sewage disposal plants, and the only kind of plant that could produce results in accord with the literal meaning of these stipulations as to results would be intermittent sand filters, and they would be very expensive."

Dr. Emil Kuichling (Vol. 3, p. 1846, fol. 2708):

"Q. Well, Mr. Kuichling, *assume* that the additional lawful means are such additional means as may be necessary to produce this effluent. A. In that case there would be a much greater reduction of nuisance or trouble of any kind than I have mentioned."

The difficulty which some of the witnesses experienced in ascertaining the meaning and purpose of questions of defendants' counsel directed toward showing that an assumed condition of affairs would be as assumed, is shown by the following extract from the testimony of Robert Spurr Weston (Vol. 3, pp. 1985, 1986):

"Q. Won't you answer my question, Mr. Weston. I asked you whether you have assumed the effluent which is described in this stipulation? A. I have not assumed an effluent from which there will be absence in New York Bay of visible suspended particles coming from the Passaic Valley sewage, because I believe that the project cannot furnish such a sewage. Second, nor one from which there will be an absence of deposits, for I believe that deposits will be produced in the harbor as the result of the discharge of this sewage. Nor that there will be absence in New York Bay and its vicinity of odors due to the putrefaction of organic matters contained

in the Passaic Valley sewage thus discharged, because I believe the sewage will smell bad. Fourth, that there will be practical absence on the surface of New York Bay of any grease or color due to the discharge of the Passaic Valley sewage, for I believe there will be an unusual proportion of gas in sewage treated as described in this stipulation. Fifth, that there will be no injury to the public health which will be occasioned by the discharge of said sewer into the Bay of New York in the manner proposed and no public or private nuisance will be created thereby, because I believe that if treated as described in the specifications there will be a danger to public health because sewage if so treated, treated in the manner proposed, will be a public or private nuisance.

"Q. Then after going into detail, I suppose you can answer my question that you are not assuming an effluent such as is described in this stipulation. Cannot you answer that question; that is the question I ask you? A. I cannot answer the question honestly *because I believe the means to produce that effluent describe one kind of effluent and the effect stipulated to be produced describes another.*

"Q. Cannot I get you to answer my question yes or no? I ask you if in your testimony you have assumed an effluent such as is described in this stipulation, yes or no? A. If you will confine your question to those certain paragraphs of that stipulation, I can answer yes.

"Q. Is there any description of effluent except those specific paragraphs contained in the stipulation? A. None of the effluent but of the devices.

"Q. Very well, I ask you about the effluent. I am not asking about the devices. I am asking you whether you are assuming an effluent such as is described in this stipulation in the testimony which you have given in this case? A. I am not assuming an effluent like that described in the paragraphs which I have just mentioned.

"Q. Please *assume such an effluent* and state what in your opinion will be the result upon the

various industries and specifications which you have testified to? A. It will be discharged without any danger.

"Mr. Riker: That is all.

Redirect examination by Mr. O'Sullivan:

"Q. *Is it feasible to secure such an effluent, Mr. Weston, by the devices described?* A. *Absolutely impossible.*"

Without unnecessarily prolonging this brief, it will be impossible for us to add to the testimony quoted above, the testimony of the many other witnesses who, after careful study into the problems here involved reached the same conclusions as have been already set forth. It is sufficient to point out that these witnesses included R. A. C. Smith, Chairman of the Committee on Harbor and Shipping of the Chamber of Commerce and Chairman of the New York and New Jersey Joint Commission on Harbor Improvement; Henry R. Towne, President of the Merchants Association of New York, Vice-President of the American Society of Mechanical Engineers and a student of Sanitary Engineering for nearly forty years; Edward Hatch, Jr., Chairman of the Committee on Pollution of the Waters of New York of the Merchants Association, representatives of other organizations interested in the public welfare, and also many other physicians and sanitary engineers, all of whom were especially qualified to testify.

Defendants' Witnesses.

Six witnesses testified on behalf of defendants as to the effect of the proposed discharge of the Passaic Valley sewage into the harbor waters of New York. All these witnesses based their opinions upon an assumed ability of the harbor waters to assimilate this sewage without harm. None of them, however, had any satisfactory knowledge of the present condition of the harbor waters and

their ability to assimilate additional sewage and four out of the six did not profess to have any such knowledge. One of the defendants' expert witnesses, General Henry Martyn Robert, admitted that he was not an expert in sewage matters and apparently, from his admissions, obtained all his knowledge as to sewage disposal from reading up on the subject in the Encyclopedia Britannica. We propose to consider with some particularity the opinions given by defendants' expert witnesses, together with their qualifications to testify.

Asa Henry Phillips testified that in his opinion the discharge of the Passaic Valley sewage as proposed by the commissioners into the harbor waters of New York would be unaccompanied by visible suspended matter upon the surface of the waters, that there would be an absence of odors, a practical absence of grease or color, that no public or private nuisance would be caused and that there would be no reduction of the oxygen contents of the waters so as to interfere with major fish life (pp. 2329-2330).

Phillips graduated from Lehigh University, School of Civil Engineering, in 1890, and since that time has been connected with the Engineering and Sewerage Department of the District of Columbia. He was appointed superintendent of this Sewerage Department in 1908 (Vol. 3, p. 2321). In connection with his work at Washington he had "made a number of visits to, and studies of drainage work in Eastern States and along the seashore" (*Id.*, p. 2321). His opinion as above set forth concerning the effect of the proposed Passaic Valley Sewerage project upon the harbors of New York was "based upon his (your) experience at Washington and elsewhere" (Vol. 3, p. 2329). His knowledge of the present condition of the waters is bounded as follows: He had read the reports of the Metropolitan Sewerage Commission (Vol. 3, p. 2332) but it is not clear that he read them carefully (See *Id.*, p. 2340). He was asked by defendants' counsel if he was familiar with New

York Bay and replied "I have been on it and around it for more than twenty years, rather frequently" (*Id.*, p. 2327) and for the purpose of testifying in this case within ten days prior to giving his testimony he had "been around on a number of water-fronts down the Bay" (*Id.*, p. 2327). Aside from information which he had gained in this manner he testified that he had no knowledge as to the conditions in New York Upper Bay (*Id.*, p. 2340).

We believe this Court will see upon reading the testimony of Phillips that it comes to no more than this: That the plant which the Passaic Valley Sewerage Commissioners propose to erect on the Newark meadows is a more efficient plant for the purification of sewage than the one over which Phillips is superintendent at Washington (*Id.*, p. 2328), and the proposed method of discharge of the Passaic Valley sewage from multiple outlets in forty feet of water is a more efficient method of discharge than that used at Washington (*Id.*, p. 2329). Phillips was therefore of the opinion that since the Washington plant created no nuisance in the Potomac (although he admitted that at one time there was an odor at the outfall from this plant, *Id.*, p. 2351), the Passaic Valley system would not create a nuisance in New York harbor.

Phillips was obviously in no position to state that the conditions in New York harbor were the same as those in the Potomac, nor did he attempt to make such a statement. It seems hardly necessary to point out that the question of the ability of the harbor waters of New York to assimilate the proposed vast increase of sewage without harm is not so simple a problem that it may be satisfactorily determined by a consideration of the success or failure of the existing sewage disposal system of the District of Columbia.

Defendants' next witness, Wiliam M. Brown, was chief engineer of the Passaic Valley Sewerage Commissioners (Vol. 3, p. 2355). Brown had been engaged for most of his

life on the Metropolitan Sewerage work of Boston (*Id.*, p. 2354). He testified as follows:

> "Q. In your opinion, will or will not the effluent produced from the works as specified produce the results which are guaranteed in the stipulation which you have before you? A. I think they will, yes, sir." (Vol. 3, p. 2358).
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> "Q. In your opinion, from your experience with the Metropolitan sewerage district of Boston, do you or do you not think that the discharge at Robbins Reef will be a safe one? A. I do, entirely so.
>
> "Q. How long do you think it will be a safe one? A. Say until in the neighborhood of 1940, thirty years."

It is to be noted that when Brown testified that the effluent produced from the works as specified will produce the results which are guaranteed, this should by no means be construed into meaning that the effluent will be as described in the stipulation when it issues from the places of discharge. The distinction between the effluent as it comes from the places of discharge, which is not referred to in the stipulation, and the condition of New York Bay, after the discharge, which the stipulation purports to cover, is clearly pointed out by the learned counsel for the defendants, as follows (Vol. 3, p. 2407):

> "Mr. Riker: The question is objected to on the same ground that has been urged on several occasions—that the effluent itself is not stipulated for nor described, but the results to be produced in New York Bay only are stipulated for and that it might well be that an effluent to produce those results in Newark Bay would be a very different effluent than the effluent which would produce the results in New York Bay."

When the witness Brown, therefore, testified, as above quoted, that the "effluent produced from the works as speci-

fied," in his opinion, would "produce the results which are guaranteed in the stipulation," he merely stated his opinion based mainly upon his experience in Boston, that the harbor waters would be able to assimilate without injury this proposed vast increase in the amount of pollution. The weight to be given to Brown's testimnoy, therefore, depends, as does the value of the testimony of all the witnesses, upon his knowledge of the condition of the harbor waters. As to this the following extracts from his testimony are significant (*Id.*, p. 2363):

> "Q. What study have you given to New York Bay and contemplated sewage discharges into New York Upper Bay and its capacity for digesting or assimilating such sewage? A. Practically nothing of recent date.
>
> "Q. What knowledge have you of the current and movements of water in New York Harbor? A. Very little."

* * * * * * * * *

Again he was asked (*Id.*, p. 2367):

> "Q. How much dilution (pollution) is there now in New York Upper Bay? A. I do not know.
>
> "Q. What portion of the flood on each flood tide consists of water that has already been in the harbor and been diluted (polluted) heavily? A. I do not know.
>
> "Q. And yet are not these necessary for you to know when you are entertaining the question of solution (dilution)? A. I do not think so.
>
> "Q. No matter how polluted the water was it was unnecessary for you to know as a basis for determining the question of the effect of the dilution (pollution) from the Passaic Valley sewerage to be discharged into it? A. *I did not say that, I said I did not know what the pollution of New York Bay was.*"

The fact that the witness Brown did not attach much importance to the plant which is to be erected on Newark

meadows is shown by his testimony that he originally recommended the discharge of crude sewage without treatment in New York Bay off Robbins Reef and that at the time he testified he thought that that was the best system of disposal for the Passaic Valley sewage (*Id.*, p. 2369).

The next witness sworn in behalf of defendants was General Henry Martyn Robert, graduate of West Point in 1855, President of the Board of Engineers for Fortifications, and President of the New York Harbor Line Board from 1895 to 1901 (Vol. 3, p. 2371).

In view of the fact that the General admitted that he was not a sewage expert (*Id.*, p. 2373) and that his opinion was worthless concerning the questions upon which he was called to testify, it seems hardly worth while to point out that the General's opinion of his testimony was correct. Such testimony as he did give seems to be based largely upon reading up in the Encyclopedia Britannica upon the subject of sewage disposal (*Id.*, p. 2374). The following extracts from the General's testimony will show his qualifications to testify in this case (Vol. 3, pp. 2373-2374):

> "Q. Have you any knowledge, General, of the amount of deposit of sewage matters in the waters of the upper bay? A. You mean New York Upper Bay?
>
> "Q. New York Upper Bay. A. I understand there is a great deal, sir; I only know it from reading, that there is a great deal, and especially near the shores.
>
> "Q. Do you regard these sewage deposits, General, as a more prolific source of pollution than the fresh sewage discharged into these tidal waters? A. My opinion would be worth nothing on that, sir, I really don't know sir.
>
> "Q. What index, General, do you take to measure the capacity of waters to receive sewage discharges? A. As I stated sir, I am not an expert at all on that matter and come to it purely from the position of a

> harbor engineer having had to design a good many of the harbors of the United States and having to look out for them with respect to the interference with channels more particularly and am not an authority on these matters to which you refer; my opinion would really be worthless upon them if I had any at all."

The General had a rather low opinion of the efficiency of the plant to be erected in the Newark meadows in accordance with the stipulation with the U. S. Government set forth in Complainant's Exhibit No. 135. He testified that so much mineral matter alone, exclusive of organic matter, would pass through the proposed plant that if the outfall were placed in Newark Bay the deposits would accumulate in a short time so as to interfere with navigation (*Id.*, p. 2377). The General said (*Id.*, p. 2377):

> "The project provides for an approximate discharge of about forty-five million cubic feet of sewage per day which estimated simply at the weight of water, would amount to about twenty-eight million pounds, which would amount at least to twelve hundred cubic yards of solid deposit per day, or, during the year, to over four hundred thousand cubic yards of deposit. The entrance to Newark Bay is quite shallow and the deposit of nearly half a million cubic yards each year of solid matter there would mean a great deal of injury to the channel."

The next witness who testified in favor of defendants was Samuel M. Gray, who stated his profession to be a civil and sanitary engineer (Vol. 3, p. 2383), of Providence, R. I. The witness Gray was of the opinion that if the processes of partial purification specified in the stipulation with the Government were put into effect by the Passaic Valley Sewerage Commissioners, the results that are guaranteed by the State of New Jersey and the Passaic Valley Sewerage Commissioners would be attained (*Id.*, p. 2386).

The value of this opinion is entirely taken away by the fact that the witness had absolutely no knowledge concerning the present pollution of the Bay, the action of the tides or apparently any other facts which it would be necessary for a witness to have in order to give the testimony which he gave. The following extracts from his testimony will make this clear (*Id.*, pp. 2384-2385):

> "Q. Have you any especial familiarity, or what familiarity have you, with the waters of New York Bay? A. My knowledge of them is simply what I have seen travelling back and forth over the Bay, and particularly on my way south and west and returning, and occasionally on excursions down the Bay. I have not examined them personally with direct reference to this case."
>
> . . . . . .
>
> "Q. In your passing up and down from your home city to the various points you have visited, over the waters of New York Bay, have you made any observations of any kind as to the condition of the waters of New York Bay so far as they are affected by sewage discharged from New York? A. I have simply made casual observations by sight and by seeing if there were odors, as I have often been somewhat surprised that the vast quantity of sewage emptied in from New York has not produced worse conditions. That is the extent of my observation."

George S. Greene, Jr., a Civil Engineer, was the next witness for the defendants (Vol. 3, p. 2425). In 1903 he had made a report to the Passaic Valley Sewerage Commissioners (Vol. 3, p. 2427; for Report see Vol. 1, p. 57), based on the report of another, in which he gave his opinion that the discharge of the Passaic Valley sewage would not cause a nuisance in the harbor waters of New York. Since his report in 1903, the witness had made no special investigation of harbor conditions (*Id.*, p. 2434). The wit-

ness admitted he had never been in charge of (*Id.*, p. 2435), nor had he ever had any direction of or control over sewage disposal works or sewage protection projects (*Id.*, p. 2436). He regarded the oxygen test as a fair measure in order to discover the extent of pollution of the water of the Harbor (*Id.*, p. 2435), but knew nothing of the oxygen content for the Upper Bay (*Id.*, pp. 2434-2435) or what it should be.

The opinion of the witness Greene, as expressed both in his report and in his testimony, was based not on bacteriological considerations (*Id.*, p. 2427), he was not a bacteriologist (*Id.*, p. 2425); nor on chemical considerations (*Id.*, p. 2427), he was not a chemist (*Id.*, p. 2425), but solely on "dilution" (*Id.*, p. 2427; Vol. 1, p. 59). The rough and inaccurate character of the witness's work is clearly apparent. It appears he had obtained a statement from the United States Coast Survey Report of 1886 showing the tidal flowage in New York Harbor. From this statement he reasoned as follows (Vol. 1, p. 59):

> "The volume of flowage of the North River as given above on the ebb tide is about 7,000,000,000 cubic feet, or 14,000,000,000 cubic feet per day into which the sewage is to be discharged.
>
> "The volume per day of sewage discharged being 46,000,000 cubic feet and the volume of flowage per day being 14,000,000,000 cubic feet, the sewage is 1/304 or 0.00328 of the volume of flowage, in other words, less than 1-3 of 1 per cent. It is obvious, I think, that such a small amount of sewage in so large an amount of other water can have but little effect, if any, that is perceptible to the senses."

It is perfectly obvious even to the lay mind that the above estimate of the ratio of the Passaic Valley sewage to the amount of clear water is based upon the assumption not only that the Passaic Valley sewage is the only sewage that is in the Harbor, but also that the 14,000,000,000 cubic feet of water which returns to the Harbor from the

sea in each day does not contain any sewage. Inasmuch as both of these assumptions are entirely contrary to the undisputed facts, the value of the opinion of the witness Greene based upon these assumptions is reduced to a minimum.

This theory of the witness, that the difference between the volumes of water at ebb and flood tides would satisfactorily take care of the Passaic Valley sewage without injury to the Harbor was referred to in the testimony of Dr. George A. Soper, who said (Vol. I, p. 433):

> "Our studies led to the opinion that an intermittent thorough mixing of the Passaic Valley sewage with the water could not be expected to occur promptly, and that the backward and forward oscillations of the tide would carry sewage sometimes to the very opposite direction from the ocean. It seemed that we would have to reject the idea that the sewage would be promptly carried to sea, and consider only whether it could be assimilated or digested by the water of the bays and rivers in the vicinity of New York."

Obviously, if all that it was necessary to know, in order to determine the effect of the proposed discharge of the Passaic Valley sewage into the harbor waters of New York, was the report of the United States Coast Survey of 1886 as to tides, the exhaustive researches made by the New York Bay Pollution Commission and the Metropolitan Sewerage Commission and the intricate studies by the distinguished scientists who testified in behalf of complainants, were productive of no useful results and represented merely a waste of time and money.

The last witness for defendants upon the main case was George A. Johnson, who testified that his profession was a consulting engineer and sanitary expert (Vol. 3, p. 2446). The witness was of the opinion that the proposed plant to be erected on the Newark Meadows would

produce the results in New York Bay which are set forth in the stipulation with the Government of the United States (*Id.*, p. 2450). It is impossible to find in the witness's testimony any statement of the principles which he followed in arriving at the conclusion to which he testified. The witness adopted the statement of the Metropolitan Sewerage Commission Report for 1912 that at that time at the mouth of the Hudson River the oxygen contents on both sides was 56 per cent saturation and at the mouth of the East River was 55 per cent (*Id.*, p. 2455). He nevertheless was willing to testify that

> "the plain facts are in this instance that the diluting powers of New York Bay waters have not been reached, anywhere near" (*Id.*, p. 2581).

This is in line with the statement of the witness (*Id.*, p. 2458) that if the sewage is well mixed with the waters of the harbor, these waters are capable of assimilating the sewage from 18,000,500 persons (*Id.*, p. 2458).

Moreover, the witness Johnson was careful to say, not that the present condition of New York Harbor would be sufficient to assimilate the sewage of 18,000,500 people, but merely that such would be the case *if the sewage was well mixed with the water.* The point is not what the harbor waters are capable of assimilating if the sewage is well mixed with these waters, but only what they are capable of assimilating under the tidal conditions existing in the harbor. As to this matter, the witness Johnson had no satisfactory knowledge. The fact that the discharge of the Passaic Valley sewage would reduce the oxygen content in the Hudson River below that of 56 per cent which he testified to exist at present, did not seem to be considered by the witness. The witness had never taken a degree in civil engineering. He was not a bacteriologist, nor was he a chemist (*Id.*, p. 2462).

The witness Johnson, although not a chemist, undertook to make certain experiments by discharging water

dyed with the so-called Red R dye in the harbor waters of New York near Robbins Reef to ascertain whether this water would make its appearance upon the surface of the bay. The fact that he was unable to observe any indication upon the bay of this dyed water was one of the reasons which led the witness to the opinion above expressed that the discharge of the Passaic Valley sewage would not produce a nuisance in the bay. The worthlessness of these experiments upon which the witness Johnson based his testimony was completely shown on rebuttal by Dr. Edward Ellery (*Id.*, pp. 2824, *et seq.*), who was a distinguished chemist (*Id.*, pp. 2023, 2024, *et seq.*).

If the witness Johnson had testified that the New York Harbor waters were capable of assimilating the sewerage for 18,009,500 people, such a statement would be entirely without weight as having no sufficient basis in the knowledge of the witness. And even if the witness were a bacteriologist or a chemist, and had shown a familiarity with the oxygen content of the waters of the bay at the present time, we submit that his testimony upon this vital fact would be completely disproved by the carefully considered opinions of the distinguished scientists whose testimony we have reviewed.

Rebuttal:

We have shown that notwithstanding the fact that the witnesses who testified in behalf of the defendants based their opinions upon an assumed ability of the harbor waters to assimilate without harm the vast increase of pollution which is proposed by the Passaic Valley Sewerage Commissioners, none of these witnesses had any satisfactory knowledge whatsoever concerning the ability of the harbor waters to perform this assumed function. The opinions of these witnesses who testified for defendants were based upon an assumed state of affairs, concerning

which they knew little or nothing, and which state of affairs the witnesses for complainants with complete knowledge testified did not exist. Under these circumstances it seems hardly worth while to take up in detail the inaccuracies of the statements made by some of the witnesses for defendants. We desire to emphasize, however, the total inadequacy of the proposed plant to be erected upon the Newark meadows and completely to answer two arguments of the defendants, namely, that the discharge of the Passaic Valley sewage in the manner proposed will not pollute New York Bay to any greater extent than it is now polluted by the discharge of the same sewage through the Passaic River, Newark Bay and Kill van Kull, and also that the method of sewage disposal disclosed by the defendants is the best method available for the district. To these ends we quote the following extracts from the testimony of complainant's witnesses on rebuttal:

James J. Powers, a contracting engineer in sanitary and hydraulic work and specialist in sewage purification, inventor of methods of antiseptic sewage treatment and student concerning the operation of plants designed to secure efficiency in sewage purification, testified in behalf of complainants as to the efficiency of the plant proposed to be erected on Newark Meadows for the purification of the Passaic Valley sewage (Vol. 3, pp. 2634, 2635, 2637, 2638):

> "It is proposed in this exhibit to discharge an effluent into the Harbor of New York at Robbins Reef that has passed through grit chambers where heavy matters may deposit, if they will, then screened through a series of screens. First coarse screens placed in the flow to arrest the coarse matter and then pumped into a screen with mesh openings of 4/10-inch, through which it passes into tanks, where it deposits any sediment that will deposit during a flow of 15 feet per minute through

the tank. In practical operation, as a matter of fact, the sewage will arrive at the sewer works after a flow of many miles. A large percentage of it has already been pumped. The whole has had the friction, attrition and resistance incident to such flow, the result being, of course, that all the feces will be broken up into small particles, all of which will readily pass through screens of 4/10-inch mesh.

"The rags, paper, pieces of soap, vegetable refuse and solidified grease having more resistance to separation will be arrested in the screens, provided it is found possible to operate them. In practical operation there will be tons of lint, shreds of fibre from the silk, cloth-finishing, dyeing and leather works and the laundry operations incident to a population of 734,396 persons in the district which this sewer will serve."

* * * * * * * * *

"Based on my own practical experience in screening sewage during the past 40 years—is that the screens will foul so rapidly that they will have to be dispensed with and that all the excreta will pass through the screens.

"If there is no provision made for precipitation or disinfection, the settling tanks will contain all the feces and grease in an advanced state of offensive decomposition, part of it floating and part on the bottom, and the intervening depth of semi-fluid filled with flocculent matter in a transition state, alternately falling and rising as they become gaseous.

"A large part of the contents will be a slimy, mucilaginous mass of partly dissolved feces, grease, and pulpy residuum that certainly should have some treatment, either filtration, precipitation or admixture, to make the fluid portion fit for discharging into the outlet sewer."

* * * * * * * * *

"It would appear that in addition to the soap solution from laundry and domestic wastes, from the large silk treatment works, and from the small

silk throwing, cloth and other manufacturing interests that use soap, there would be in solution in the daily discharge many tons of soap.

"This enormous amount of soap solution would seriously affect the provision in the stipulation of the Passaic Valley Sewerage Commission with the United States, wherein the Passaic Valley Sewerage Commission has agreed that the effluent discharged by them at Robbins Reef will create no discoloration of the waters of the harbor. It is impossible to discharge this amount of soap solution into salt water without creating soap granules and scum upon the surface; the mere admixture of the soap solution with the salt water produces coagulation and an insoluble calcium stearate, which will spread out on the surface of the harbor and certainly create discoloration.

"Now, in verification of that, I would like to refer to Report on Sewage Disposal of the City of Paterson, June 30th, 1906. The following is from page 93, paragraph 5, Report on Sewage Disposal of Paterson, New Jersey: 'It must be admitted that New York is better off without the discharge of New Jersey's sewage. The discharge of sewage will tend to pollute the Bay locally. There will be an appearance of sewage for some distance around the proposed outlet, and this outlet is near the Main Channel of the Harbor. There will be some odor and grease, for the sewage will smooth the waves and show its presence over a considerable area.'"

Emil Kuichling testified as to the effect of the proposed treatment of the sewage in the plant on Newark Meadows as follows (*Id.*, pp. 2716, 2717):

"By reason of the septic character of the sewage, its long course of transit, the action of the pumps and the additional fermentation that must inevitably occur in the sedimentation tanks in warm weather, the solid matters which are carried in suspension in the liquid will be extentively comminuted. This reduction of size renders their sedimentation more difficult, and a much

smaller quantity of such matter will be deposited in the tanks than if the sewage were fresh and flowed quietly by gravity into them. Mr. George A. Johnson has testified for the defendants in this suit that in his opinion about 35 per cent. of the total amount of suspended matter would be deposited in the proposed sedimentation tanks during a period or from 1 to 1½ hours, and he based this opinion on the results which he obtained with fresh sewage at Columbus, Ohio, in a tank with a period of detention therein of 1.3 hours. These results indicated a removal of 34 per cent. of the suspended matter, as given on page 78 of Mr. Johnson's report published in 1905. This shows that 66 per cent. of the suspended matter escaped with the tank effluent, and it is evident to every one who is familiar with sedimented sewage that most of these particles of matter will be plainly visible in the liquid."

Referring to the provision in the stipulation for a period of sedimentation of one and one-half hours, Mr. Kuichling said:

> "In my opinion this period of time is inadequate in warm weather to secure the removal of even 30 per cent. of the suspended matter in the sewage that will enter the proposed settling tanks. The reasons for this opinion have already been given; and supplementing my previous answer, I believe that a countless number of particles of matter contained in the effluent from said tanks will be plainly visible in the water of the Bay near Robbins Reef Light."

In order to demonstrate the error in a statement made by the witness Johnson, in behalf of defendants, that the completion of the Passaic Valley project would not cause any more pollution in the Bay from the Passaic Valley than that caused at present through Newark Bay and the Kill van Kull, Professor Earle B. Phelps made a number of investigations as to the oxygen content of the waters

of the Bay near Robbins Reef and those of Kill van Kull. These examinations showed, said Professor Phelps, that "it can be safely asserted that no serious additional burden is being placed upon the purifying capacity of New York Harbor waters by the pollution which reaches the Harbor through Kill van Kull" (Vol. 3, p. 2734). This would be entirely different, however, if the proposed Passaic Valley sewage project were permitted to be completed. Professor Phelps testified (Vol. 3, p. 2735):

> "The Passaic Valley district is not today an important factor in the pollution of New York Harbor waters. On the other hand, the addition of a large volume of sewage to the upper New York Bay would throw a heavy burden upon the purifying power of those waters. All the oxidizing work which Newark Bay is now doing will have to be done in New York Bay. The discharge of 350 million gallons of sewage at Robbins Reef would throw such a burden upon the waters of New York Bay that the dissolved oxygen would be lowered to at least 40 per cent of saturation by the most conservative calculation. This calculation is based upon the average oxygen requirement of city sewage and upon the power of reaeration existing in New York Harbor determined by methods that are all in evidence in my direct examination. The continued discharge of this volume of sewage under all tidal conditions would result in carrying pollution to the uppermost limits of New York City and computations of the effect of such discharge upon the waters of the Hudson River at Spuyten Duyvil show that during the summer season the dissolved oxygen at that point would be reduced on the average of 25 per cent of saturation. For comparison of this figure, I wish to state also that some determinations of the dissolved oxygen of the Passaic River at Newark, made in January, 1911, by me, showed that the waters of the Passaic River at Newark contained at that time 38 per cent. of saturation of dissolved oxygen."

Any argument by the defendants that the proposed method of abating the present nuisance in the Passaic River is the best that can be devised is entirely taken away by the following testimony of Rudolph Hering, one of the originators of the method and a distinguished engineer (thus described in the defendants' answer, Vol. 1, p. 35), who testified on cross examination by defendants' counsel (Vol. 3, p. 2868):

> "Q. And you know that the purpose is to prevent the carrying into actual effect of plans which you have submitted and which you have approved in Defendants' exhibit No. 5, don't you?
>
> * * * * * * * * * *
>
> A. I know that, sir, and I have already testified that if I were to advise on this Passaic Valley Sewerage treatment, I should certainly advise differently owing to the very radical changes that have occurred since that time; and in view of the present economical possibilities of treating sewage in a better way, all of which would cause me, as a consulting engineer, to advise something better than I did a few years ago, when nobody on this earth knew about the possibilities of which we know today, and of which we have absolute proof."

We submit that the case of the complainants has been established.

***Second.*—The stipulation between the Passaic Valley Sewerage Commissioners and the Government of the United States wholly fails to afford assurance of protection and furnishes no defense to this suit.**

The stipulation (Vol. 1, p. 109), was entered into on April 14, 1910, long after the institution of this suit. The stipulation was made with the United States, acting through the Attorney General, as an intervenor in this suit, and was entered into for the purpose of securing the dismissal of the petition of intervention. The intervention of the United States in no way affected the right of the complainants to maintain this suit, and the dismissal of the intervention did not affect that right.

The stipulation with the Attorney General was not made under the authority of any Act of Congress. When the United States sought to intervene in this suit, the defendant resisted the petition. The Attorney General in his reply stated: "It is true that Congress has promulgated no law or code of laws relating to the preservation of public health, or even quarantine regulations, for the port and harbor of New York." And it was contended by the Attorney General, in substance, that "while the United States has no quarantine or senitation laws for the port of New York, the State of New York has, and these laws have been recognized, and for the time being at least virtually adopted by the United States, and it has always assisted in enforcing them." Thus the laws of New York were suggested as a basis for the intervention (Reply Brief of the Attorney General on petition for intervention in this suit, filed January 15, 1909).

It is thus apparent that there is no legislation of Congress, under the power to regulate commerce, which ousts the State of New York of its right to complain of the creation of this nuisance. The case belongs to that class

where by reason of the local exigency the State has power to intervene, both in the interest of navigation and for the protection of health and commerce, until Congress acts and prescribes applicable and exclusive rules.

Willson v. *Blackbird Creek Marsh Co.*, 2 Pet., 245;
Gilman v. *Philadelphia*, 3 Wall., 713;
Escanaba Co. v. *Chicago*, 107 U. S., 678;
Morgan's, etc., S. S. Co. v. *Louisiana*, 118 U. S., 455;
Missouri, Kansas & Texas R'y Co. v. *Haber*, 169 U. S., 613;
Compagnie Francaise, &c. v. *Board of Health*, 186 U. S., 380;
Reid v. *Colorado*, 187 U. S., 137, 138.

And as Congress has not acted so as to provide exclusive regulations for the protection of health and commerce in the port of New York, the State of New York has not been ousted of its right and duty to protect its citizens.

It is not necessary to discuss the broad principles governing intervention by the United States in suits between States (*Florida* v. *Georgia*, 17 How., 478, 493), for it would seem to be clear that where there is no Act of Congress providing a scheme of exclusive regulation, and thus ousting the State of its protecting power with respect to navigable waters, this result cannot be accomplished by an intervention of the Attorney General after the State has brought its suit.

The stipulation then, on the dismissal of the intervention of the United States, is a mere agreement relating to that dismissal. The scope of the authority of the Attorney General to make agreements on the part of the United States, the basis for which is not found in any Act of

Congress, but is predicated solely upon an implied authority in connection with the appearance of the United States as an intervenor in a suit between States, is far from clear. If it be recognized as an unlimited authority, there is a way open to bind the United States in an unprecedented manner without the authority of any appropriate legislation by Congress. It will readily be seen that stipulations might thus be entered into which, if they had the effect of binding agreements, and particularly if they had the effect of ousting appropriate suits by States, would deprive both the State and Nation of all needed protection in a serious exigency.

The power to regulate commerce is confided to Congress and not to the President or to the Department of Justice. The authority of the State to protect itself with respect to local needs in the absence of action by Congress is inherent in our system of government. And no implication of authority on the part of the Attorney General to dispose of an intervention in a suit to which the United States is not an original party can go so far as to destroy the State's right to protect itself in a matter in which Congress, although it may have the right to intervene, has not intervened.

It is said, however, that the performance of the stipulation with the Attorney General, on the dismissal of the intervention of the United States, was subsequently made a condition of the granting of the permit by the War Department for the construction of the outlet and shaft house in the bay. The Secretary of War in granting this permit, was acting under the authority of Section 10 of the Act of March 3, 1899, chapter 425 (30 Stat., 1151), which relates simply to physical obstructions. The authority of the Secretary of War only extended to the consideration of the proposed erection as a possible physical obstruction to navigation. Congress did not attempt in this limited provision to establish, and had not otherwise

established,—as the Attorney General of the United States stated before this Court upon the application for intervention (*supra*)—a sanitary code or a plan of regulation for the protection of health and commerce and with respect to nuisances of the sort here under consideration. Section 10 of the Act of March 3, 1899, relates to obstructions to the "navigable capacity," such as wharves, piers, bulkheads, jetties, and other structures in navigable waters.

The granting of the permit by the Secretary of War for this physical construction in the bay could not in any way impair the right of the State of New York to object, not to the structure, but to the pouring out of this putrid mass into the bay to the injury of the health and commerce of its people.

To repeat, the Secretary of War may authorize the structure if he does not think its erection will obstruct the "navigable capacity" of the waters, or channel, that is, the passage, the mooring, the handling, of vessels. The State of New York is not resting its case upon a consideration of this mere structure or of its relation to "navigable capacity." It is dealing with the protection of health and commerce, with which the State of New York, in the absence of appropriate and exclusive regulation by Congress, is chiefly concerned; which it has a right to safeguard in this matter involving sewage pollution, which is a concern outside the official duty of the Secretary of War.

The granting, therefore, of the permit for the structure could not establish the right to pour this sewage into the bay.

It also follows, that the attempt, to impose conditions relating to the sewage, in granting the permit with respect to the physical structure,—whatever may be the legal effect of these conditions in other respects—cannot oust the State of New York of its right to complain.

Where Congress has not taken appropriate and exclusive action to protect the health and commerce of the port in a case of this description, the State of New York is not bound to await the actual injury and trust to the action of Federal officers under conditions of permits. This action may or may not be taken. The Court knows well the *vis inertiae* of Government. The Court fully understands the great difficulties in undoing a thing that has been accomplished. It is easy to say that the Secretary of War has attached conditions to the permit, but when thirty municipalities of New Jersey are pouring their sewage into the bay, the revocation of such a permit would be an extraordinary executive action to which the State of New York is unable to look forward with any degree of confidence. We are not impugning the good faith or the good intentions of officers, past, present or future. It is well known, however, that when methods of operation have once been established and their change will have a very serious effect upon communities, executive officers rarely exercise rights of revocation.

But the question whether a Federal officer would revoke this permit is beside the mark. The point we submit is that the State of New York, if it has established its case against the outpouring of this sewage and offensive trade waste in New York Bay, as we think it has, is not to be denied the appropriate remedy because of what a Federal officer may or may not do in an unknown contingency with respect to matters which are left to the exercise of his official discretion.

As Congress has not seen fit to take charge of a matter of this sort, in its broad aspects relating to health and commerce, the States stand on their original rights of local protection, and the State of New York comes to this Court with a controversy which is to be decided upon its merits and not upon speculation as to executive action.

We have thus far considered the stipulation as though its terms were other than illusory. But an analysis of its

provisions will show how far they are from affording, in any event, assurance of protection.

(1) It will be noted that there is no agreement wih the State of New Jersey. The stipulation does not purport to bind the State of New Jersey. It is between the United States and the Passaic Valley Sewerage Commissioners. It is true that the stipulation recites that the State of New Jersey has authorized the Passaic Valley Sewerage Commissioners to make this adjustment, but when the stipulation was entered into the State of New Jersey did not become a party to its promises. It was clearly intended that the State of New Jersey should not become a party to these promises, and Chapter 158 of the Laws of 1910 of New Jersey (p. 267), which recited the controversy and the proposed stipulation, simply authorized the Commissioners "for themselves and their successors" to enter into a stipulation and contract to the effect and for the purposes stated. The covenants in the stipulation are that "The Passaic Valley Sewerage Commissioners agree," etc.

So far as the promises contained in the stipulation go, they will last no longer than the Commissioners themselves or their office. On the other hand, a decree in this suit will bind the State of New Jersey.

(2) The stipulation (Vol. 1, p. 109) in its First paragraph sets forth a description of the plant which is to be provided. We have already discussed the insufficiency of this plant and the utter impossibility of its avoiding the injurious results that have been described.

It is manifest that neither the defendants nor the Government were willing to risk a promise based on the sufficiency of the plant described in the First paragraph.

(3) The Second paragraph of the stipulation contains the covenants as to results. But this paragraph does *not* say that the plant and devices and method of operation

described in the First paragraph will accomplish the desired results. There is *no* covenant in the stipulation that the described plant will accomplish the desired results. On the contrary, the necessary implication is that it will not, for the defendants were unwilling to agree that it would.

The Second paragraph of the stipulation reads as follows:

> "Second. The Passaic Valley Sewerage Commissioners further agree with the United States that in the operation of said sewer system at all times the following results shall be secured, *either* through compliance with the requirements of the immediately preceding paragraphs, *or through requisite lawful additional arrangements*, viz.:
>
> (1) There will be absence in the New York Bay of visible suspended particles coming from the Passaic Valley sewage.
>
> (2) There will be absence of deposits objectionable to the Secretary of War of the United States in the New York Bay coming from the Passaic Valley sewage.
>
> (3) There will be absence in the New York Bay and its vicinity of odors due to the putrefaction of organic matters contained in the Passaic Valley sewage thus discharged.
>
> (4) There will be a practical absence on the surface of New York Bay of any grease or color due to the discharge of the Passaic Valley sewage at the dispersion area or elsewhere.
>
> (5) There will be no injury to the public health which will be occasioned by the discharge from the said sewer into the Bay of New York in the manner proposed, and no public or private nuisance will be created thereby.
>
> (6) The absence of injurious effect from said sewage discharge, upon the property of the United States situated in the Harbor of New York.

(7) The absence of reduction in the dissolved oxygen contents of the waters of New York Bay, resulting from the discharge of Passaic Valley sewage, to such an extent as to interfere with major fish life."

It will thus be noticed that it is *not* agreed that these results shall be secured *"through compliance with the requirements of the immediately preceding paragraphs,"* which set forth the proposed plant and system, but that these results will be accomplished *either* through that system, or through *something else* which is not in any way defined.

(4) The whole effect, then, of the stipulation rests upon some system, plant or device which is not in course of construction, as to which no plans have been provided, which is described simply in the words *"or through requisite lawful additional arrangements."* It is hardly necessary to comment upon a situation where the parties are unwilling to agree as to the sufficiency of the only plans in contemplation to produce the desired results.

What are the other *"requisite lawful additional arrangements"?*

(a) It will first be noted that they are *"additional,"* thus emphasizing what we have already said as to the doubt of the parties themselves with respect to their present plan.

(b) They must be *"requisite."* That is, they must be required, or at least they must be necessary. But there is no definition of "requirement." It is not agreed that even the War Department shall have the right to compel the Commissioners to install what the War Department may think necessary. There is often serious difference of opinion as to what is "requisite."

(c) Again, the additional arrangements must be *"law-*

ful." Thus, if it were found necessary to make additional arrangements which would obstruct navigation, or for sufficient reasons could not be allowed, they would not be "*lawful*," and apparently the Commissioners would not be required to produce results through other arrangements, if the necessary arrangements to produce the results were not permitted. Further, local authorization might be necessary for the public undertaking, and local power to incur debts, or adequate legislation to give the needed authority might be required to make "lawful" the additional arrangements.

At this point we may again recur to the permit of the Secretary of War conditioned upon the stipulation. So far as it is conditioned upon the construction of the plant described in the First paragraph, it is manifestly not conditioned upon that which either the State of New Jersey or the Commissioners have agreed will be adequate to produce the results.

So far as the permit is conditioned upon other "requisite lawful additional arrangements," the condition cannot be regarded as broken unless the additional arrangements are authorized by law. If they involve obstructions to navigation the Secretary of War will find himself debarred from asserting a breach of condition unless he grants the permit to make performance possible. If State legislation or municipal authority is necessary to make lawful the requisite additional arrangements, no breach can be laid at the door of the Passaic Valley Sewerage Commissioners, the party to this stipulation, unless the necessary legal authority is obtained.

Whether we regard the stipulation as a condition underlying the permit, or as a promise, in both aspects it is, as we view it, wholly illusory. It is hardly worth while to spend time in discussing it. It refers to undefined arrangements of an uncertain character. Their expense may be prohibitive. They are arrangements to be

made by official commissioners who can act only within their authority. They are to be made in connection with municipalities, and these can act only to the extent to which they are authorized and within their debt limits.

And it will further be noticed that not one of the promises contained in paragraph Second of the stipulation can be deemed to be broken *unless the injurious consequence described can be traced to the particular sewage.* What this means, as a practical matter, is sufficiently obvious. This pollution mingles with the pollution from riparian communities; it is taken on the tides to the rivers and brought back; it advances and recedes; it bears no label. Every one of the promises referred to is qualified by the words "due to the discharge of the Passaic Valley sewage."

The difficulties are insuperable. The most distinguished witnesses, those conversant with all known forms of sewage disposition, are clearly of the opinion that the results stated in the Second paragraph of the stipulation cannot be attained. Of course, if they were theoretically possible of attainment, but only at a prohibitive expense, it would come to the same thing. For the municipalities affected could not bear, and would not assume, and there would be no law compelling them to assume, such extravagant outlays.

Desmond Fitz Gerald testified (Vol. 2, p. 1582):

> "I do not think it is practicable by engineering devices, however carefully designed, however expensive in construction, however elaborate in detail, to accomplish all those purposes."

John W. Alvord testified (Vol. 3, pp. 1863, 1864):

> "The fact that this stipulation calls for an almost perfect effluent except as to soluble impurities capable of absorbing some dissolved oxygen makes the stipulation in my opinion impracticable. Such results as are called for in this stipulation have never anywhere been attained on such a scale from such a sewage plant or even far more complete

plants, so far as my knowledge of sewerage purification goes. It is therefore in my opinion exceedingly difficult of enforcement because it calls for that which is practically impossible."

Prof. Charles-Edward Amory Winslow testified (Vol. 2, pp. 1666, 1669):

"* * * * I do not think there is any method that can produce those stipulated results, except at enormous expense."

* * * * * * * * * *

"Why did you say the cost of living up to those stipulations would be enormous? A. Because I am familiar with the general cost of sewage disposal plants and the only kind of plant that could produce results in accord with the literal meaning of these stipulations as to results would be intermittent sand filters, and they would be very expensive."

Prof. Earle B. Phelps testified (Vol. 2, pp. 1618, 1639):

"The cost of purifying the sewage of the Passaic Valley to the extent indicated in the stipulations would be so great that the entire advantages of the prtject as a whole would disappear. It is not feasible, therefore, from an engineering standpoint, to produce these stipulated results either by the present plant or by any additions to that plant which may be made in the future. These things are needed, possibly, but they are an exceedingly costly alternative to the simpler problems of individual treatment by the towns."

* * * * * * * * * *

"* * * * I nave not gone into it in detail, but if those specifications are followed literally, the cost of the works would be so great in my opinion that from a financial standpoint and from a political standpoint, it would be unfeasible. They could not ever do it."

We conclude that the stipulation is not available as a defense to this suit.

***Third.*—The existing condition of the waters of the Bay of New York furnishes no justification for the creation of this nuisance.**

The argument which the defendants base upon the existing conditions in the harbor of New York necessarily assumes that the action of the defendants will create a serious nuisance injurious to health, property and commerce, menacing the interests of the greatest community in the United States, to the prosperity of which is indissolubly linked the prosperity of the country. If the acts of the defendants are innocuous—if the abundant proof the complainant has supplied could be disregarded—there would be no occasion for the contention that the State of New York is debarred by its own acts from seeking relief. Unless the ground for relief would otherwise exist, it is of no consequence to inquire whether the complainant must be denied an appropriate remedy. In urging such denial upon the ground stated, the defendants confess the wrong.

But if it is established that this action on the part of New Jersey will constitute a serious nuisance, imperilling the health of the people of New York and the prosperity of this port, there is no principle which would justify a denial of relief. The State of New York does not come before the Court in the capacity of a mere owner of property, but in a *quasi*-sovereign capacity as the protector of its people. And when resort to this Court is important for the protection of such a public right, the complaint is not to be dismissed upon considerations which would have their appropriate application only in private controversies. This Court has had occasion to emphasize the broader principles which apply when States appear at its bar.

In *Virginia* v. *West Virginia*, 234 U. S., 117, 121, this Court said, by Mr. Chief Justice WHITE:

> "As we have pointed out, in acting in this case from first to last, the fact that the suit was not an

> ordinary one concerning a difference between individuals, but was a controversy between States involving grave questions of public law determinable by this Court under the exceptional grant of power conferred upon it by the Constitution, has been the guide by which every step and every conclusion hitherto expressed has been controlled. And we are of the opinion that this guiding principle should not now be lost sight of, to the end that when the case comes ultimately to be finally and irrevocably disposed of, as come ultimately it must in the absence of agreement between the parties, there may be no room for the slightest inference that the more restricted rules applicable to individuals have been applied to a great public controversy, or that anything but the largest justice after the amplest opportunity to be heard has in any degree entered into the disposition of the case."

And in *Georgia* v. *Tennessee Copper Company* (206 U. S., 230, 237, 238) the Court said, by Mr. Justice HOLMES:

> "If the State has a case at all, it is somewhat more certainly entitled to specific relief than a private party might be. It is not lightly to be required to give up *quasi*-sovereign rights for pay; and, apart from the difficulty of valuing such rights in money, if that be its choice it may insist that an infraction of them shall be stopped. The States by entering the Union did not sink to the position of private owners subject to one system of private law. This Court has not quite the same freedom to balance the harm that will be done by an injunction against that of which the plaintiff complains, that it would have in deciding between two subjects of a single political power."

It is true that in *Missouri* v. *Illinois* (200 U. S., 496, 521, 522) reference was made to the conduct of Missouri in permitting discharges of sewage into the Mississippi River. But there Chicago was merely disposing of its sewage, mixed with a vast volume of water from Lake

Michigan, into the Des Plaines River, which emptied into the Illinois River, and there was a course of 357 miles before it reached the point in question; the Illinois River emptying into the Mississippi River about 43 miles above the City of St. Louis. Not only was the discharge of a similar character to that permitted by St. Louis, but the situation was one demanding proof that the condition complained of was not caused by St. Louis itself.

In the present case, we have a joint trunk sewer collecting a mass of sewage and offensive trade waste from many municipalities, and bringing it in one volume for a distance of twenty-six miles from the Passaic Valley, and depositing it in a putrid condition at the place of discharge in the waters of the Bay at a rate which soon will reach 350,000,000 gallons a day; and we have definite proof showing the injuries that will result.

The discharge of sewage permitted by New York is the ordinary discharge by riparian communities into their adjacent waters. The conduits are only for the purpose of reaching the adjacent waters at the nearest and most convenient points. What New York thus permits, it has never sought to deny to New Jersey with respect to its communities bordering upon the Hudson and the Bay. And for a very large part of the sewage and trade waste in the inflow from riparian communities, New Jersey itself is responsible. The discharge now threatened by the defendants is of a very different sort, as we have had frequent occasion to emphasize. It is a septic stream which is collected in a vast volume, carried through a tunnel and discharged at high pressure in the waters of the Bay at the edge of the ship channel.

We put the case sharply. If by reason of the traditional manner of disposing of the sewage of a great city, the waters of the river and bay are already polluted, and the question is a serious one with respect to the extent to

which the waters of the river and bay can take care of additional discharges of this character from the riparian communities, which naturally empty their sewage into these waters, is it possible that this can be deemed a reason for permitting an abnormal increase of pollution by conducting this vast volume of sewage to the bay from these distant communities? Is New York, faced with this most serious problem of disposing of the sewage of this great centre of population, and seeking to protect itself from the additional and abnormal inflow, to be told that its own exigency deprives it of the right of protection, and because, forsooth, the sewage of the riparian communities is so great, that it has no standing to complain of the addition from the communities in the Passaic Valley?

We assert that this is a monstrous proposition. Instead of New York's serious difficulty, by reason of the existing volume of sewage, depriving it of its right, it is in very truth a reason for the assertion of its right. The State of New York is endeavoring to protect the interests of the riparian communities of New Jersey no less than those of New York, for the harbor of New York is of incalculable value to both. There is such a thing, as the evidence we have reviewed makes clear, as reaching a point of saturation with respect to the inflow of sewage. When that point is reached pestilence will stalk abroad and commerce will flee the port. It is bad enough for New York Bay to receive what may naturally reach it in a diluted condition through the emptying of adjacent waters. But an abnormal flow of concentrated filth through an artificial channel of the kind here proposed is an added menace of which New York is entitled to complain.

Equity, between these States, demands that New York's problem be considered fairly, and the extent of its present exigency is no excuse for the threatened injury.

The New Jersey communities, as has been clearly

shown, can readily dispose of their own sewage,—and if that is important,—quite as economically, without imperilling New York by the proposed method of disposition. They naturally desire to free the Passaic River of pollution, but that desire does not justify them in transferring the nuisance to New York Harbor.

***Fourth.*—The State of New York is entitled to maintain this bill, and to secure the relief asked (a) upon principles which may be deemed to be applicable to controversies between States, irrespective of the compact of the year 1833 with the State of New Jersey, and (b) by virtue of the exclusive jurisdiction reserved to the State of New York under that compact.**

(1) That the State is entitled to bring suit in this Court to redress an injury to it "in its capacity of quasi-sovereign" has been clearly established by the decisions of this Court.

Missouri v. *Illinois*, 180 U. S., 208; 200 U. S., 496;
Kansas v. *Colorado*, 206 U. S., 46;
Georgia v. *Tennessee Copper Company*, 206 U. S., 230; 237 U. S., 474, 678; 240 U. S., 650.

In that capacity "the State has an interest independent of and behind the title of its citizens." (*Georgia* v. *Tennessee Copper Company*, 206 U. S., 230, 237.) Even if the State has but slight direct pecuniary or proprietary interests involved, it stands as the representative of the collective interests of its citizens, and the same need of protection in their health and property which would make the creation of a nuisance in a navigable water a *casus*

belli in the case of independent States may properly bring it as complainant to this Court. There could hardly be a clearer illustration of the importance of this quasi-sovereign capacity of the State than exists in the present case where the State of New York seeks the protection of its metropolis, holding within its borders and within the zone of this threatened injury one-half of the entire population of the State.

What was said in overruling the demurrer to the bill in *Missouri* v. *Illinois* (180 U. S., 208, 241) applies here:

> "An inspection of the bill discloses that the nature of the injury complained of is such that an adequate remedy can only be found in this Court at the suit of the State of Missouri. It is true that no question of boundary is involved, nor of direct property right belonging to the complainant State. But it must surely be conceded that, if the health and comfort of the inhabitants of a State are threatened, the State is the proper party to represent and defend them. If Missouri were an independent and sovereign State all must admit that she could seek a remedy by negotiation, and, that failing, by force. Diplomatic powers and the right to make war having been surrendered to the general Government, it was to be expected that upon the latter would be devolved the duty of providing a remedy and that remedy, we think, is found in the constitutional provision we are considering.
>
> "The allegations of the bill plainly present such a case. The health and comfort of the large communities inhabiting those parts of the State situated on the Mississippi River are not alone concerned, but contagious and typhoidal diseases introduced in the river communities may spread themselves throughout the territory of the State. Moreover substantial impairment of the health and prosperity of the towns and cities of the State situated on the Mississippi River, including its commercial metropolis, would injuriously affect the entire State."

If an argument were sought to be made by the State of New Jersey on the ground that the action was being taken by the Passaic Valley Sewerage Commissioners, a body corporate, this also would be decisively met by the ruling in *Missouri* v. *Illinois* with respect to the Sanitary District of Chicago. The Court there said (180 U. S., 208, 241, 242):

> "The contention rather seems to be that, because the matters complained of in the bill proceeds and will continue to proceed from the acts of the Sanitary District of Chicago, a corporation of the State of Illinois, it therefore follows that the State, as such, is not interested in the question, and is improperly made a party.
>
> "We are unable to see the force of this suggestion. The bill does not allege that the Sanitary District is acting without or in excess of lawful authority. The averment and the conceded facts are that the corporation is an agency of the State to do the very things which, according to the theory of the complainant's case, will result in the mischief to be apprehended. It is State action and its results that are complained of—thus distinguishing this case from that of *Louisiana* v. *Texas*, where the acts sought to be restrained were alleged to be those of officers or functionaries proceeding in a wrongful and malevolent misapplication of the Quarantine Laws of Texas. The Sanitary District of Chicago is not a private corporation, formed for purposes of private gain, but a public corporation, whose existence and operations are wholly within the control of the State."

In the present case, the State of New Jersey answers jointly with the Passaic Valley Sewerage Commissioners, and the latter appears as the agency of the State acting under its authority and control in order to accomplish the very thing of which the State of New York complains.

Again, the right to invoke the jurisdiction of this Court would be a barren substitute for the surrendered right of a sovereign State, if the disaster must be awaited before

a remedy can be applied; if the only remedy available must of necessity be inadequate. On this point, it was said in the *Missouri* case (id. p. 243):

> "Can it be gravely contended that there are no preventive remedies, by way of injunction or otherwise, against injuries not inflicted or experienced, but which would appear to be the natural result of acts of the defendant, which he admits or avows it to be his intention to commit?"

In *Missouri* v. *Illinois*, it appeared on final hearing that the proof was insufficient. Mr. Justice HOLMES, writing for the Court, expressed the serious caution with which questions of this gravity are approached, but there was no denial of the capacity of the State to sue, or of the right to relief if a case were made out. While every matter that would warrant resort to equity in litigation between private citizens might not justify the remedial action by this Court in a suit between States, there was no ground for doubting the propriety of the exercise of its jurisdiction in the case of a serious nuisance, involving grave injury to the people of the complaining State, when shown by convincing evidence to exist or to be imminent.

In *Missouri* v. *Illinois*, the case made by the bill was far from established by the proof. Instead of collecting a mass of sewage by means of a trunk sewer, as in this case, and depositing it at the very door of St. Louis, the sewage there was conducted into the Des Plaines River, which emptied into the Illinois River, and the latter emptied into the Mississippi at a point 43 miles above the City of St. Louis. At the very start, the sewage was mixed with the water from Lake Michigan, and the journey through the open water way was 357 miles before it reached the waters adjacent to St. Louis. This characteristic feature of the proof may be gathered from the following statement in the opinion of this Court on final hearing (200 U. S., 496, 522):

> "On the contrary, it is proved that the great volume of pure water from Lake Michigan which is

> mixed with the sewage at the start has improved the Illinois River in these respects to a noticeable extent. Formerly it was sluggish and ill-smelling. Now it is a comparatively clear stream to which edible fish have returned. Its water is drunk by the fishermen, it is said, without evil results. The plaintiff's case depends upon an inference of the unseen."

And, examining the basis of that inference, it was found to be too slender to support a decree. Further, it was held that as to the discharge of the sewage into the Des Plaines River which flowed into the Illinois, the case stood in point of law exactly the same as that of a suit because of "the discharge from Peoria into the Illinois, or from any other or all the other cities on the banks of that stream" (id. p. 526). While it was urged that Chicago was not on the watershed of the Mississippi, the contention on this ground lacked support. It rested on the fact that there was a rise of a few feet between the Des Plaines and the Chicago Rivers. But as the Court pointed out, the natural features relied upon "are of the smallest" and it further appeared that Congress by action of undisputed validity had brought Chicago into the Mississippi watershed. Such an artificial collection and conducting of sewage by means of a trunk sewer to a point of discharge in the harbor of a great city as we have in this case, was not there involved. If Chicago had planned to collect its sewage and conduct it by a tunnel, without other treatment than that involved here, to a point opposite the City of St. Louis, and there deposit it in a vast volume of concentrated filth menacing the health of the City of St. Louis and the prosperity of its commerce, we imagine that a different decision upon the facts would have been reached.

It is, of course, no answer that New Jersey creates the nuisance on its own side of the boundary line. If that had been a sufficient defense, there would have been no need

for the discussion of principles that we find in *Missouri* v. *Illinois*.

Georgia maintained its case, although the Tennessee Copper Company had its works and created the nuisance in the State of Tennessee. The fumes it generated spread to the destruction of forests in Georgia. Here, New Jersey plans to throw its sewage into the waters of New York and the fact that the discharge is within a few feet of the boundary line does not prevent its constituting a nuisance of which New York may complain. Although the discharge of the sewage is on the New Jersey side of the territorial line, the sewage in the nature of things cannot stay there. In fact, the point of discharge is farther from the New Jersey shore than from the New York shore. It is a case of a pestilential flood brought to the border of the State to be poured out in tide waters to spread throughout the harbor and the sewage will inevitably be borne with every tide to Manhattan, Brooklyn and Richmond, imperilling the health of the inhabitants of those places, and injuring the commerce of our greatest city and port.

We shall discuss below the jurisdictional authority of New York under the compact with New Jersey, but, as we conceive it, the case for New York would be complete, were there no such compact.

(2) The compact of 1833 between the States of New York and New Jersey "concerning the territorial limits and jurisdiction" of the two States, fixed the boundary line from a designated point in the Hudson River at "the middle of the said river, of the bay of New York, of the waters between Staten Island and New Jersey, and of Raritan Bay to the main sea," except as otherwise particularly mentioned (Act of Congress, June 28, 1834, c. 126; 4 Stat., 708, 709; Laws of 1834 [New York], Chap. 8; Laws of 1834 [New Jersey], p. 118). But while the territorial boundary was thus fixed at "the middle of the bay of New

York," the jurisdiction of the State of New York was not confined to the waters on its own side of the line.

It was agreed that New York should have exclusive jurisdiction over all the waters of the Bay of New York, and over the lands covered by these waters to the low water mark on the New Jersey side, subject to certain specified rights of the State of New Jersey. We have placed in an Appendix to this brief the compact as ratified by the two States, and as it appears in the Act giving the consent of Congress. We quote again Article Third of the compact as follows:

> "ARTICLE THIRD. The state of New York shall have and enjoy exclusive jurisdiction of and over all the waters of the bay of New York, and of and over all the waters of Hudson river lying west of Manhattan Island and to the south of the mouth of Spuytenduyvel creek, and of and over the lands covered by the said waters to the low-water mark on the westerly or New Jersey side thereof; subject to the following rights of property and of jurisdiction of the state of New Jersey, that is to say:
>
> "1. The state of New Jersey shall have the exclusive right of property in and to the land under water lying west of the middle of the bay of New York, and west of the middle of that part of the Hudson river which lies between Manhattan Island and New Jersey.
>
> "2. The state of New Jersey shall have the exclusive jurisdiction of and over the wharves, docks, and improvements made, and to be made, on the shore of the said state, and of and over all vessels aground on said shore, or fastened to any such wharf or dock; except that the said vessels shall be subject to the quarantine or health laws, and laws in relation to passengers, of the state of New York, which now exist or which may hereafter be passed.
>
> "3. The state of New Jersey shall have the exclusive right of regulating the fisheries on the westerly side of the middle of said waters, *provided* that the navigation be not obstructed or hindered."

It is apparent that the jurisdiction which it was thus agreed was to belong to New York is a jurisdiction which excludes any conflicting action on the part of New Jersey. The jurisdiction of New York was not only to extend to the conduct of individuals with respect to the waters of New York Bay, but it was to be an *"exclusive"* jurisdiction. Exclusive of what? Manifestly, exclusive of any assertion of authority or control on the part of New Jersey which would be inconsistent with the authority and control thus vested in New York. When we ascertain the scope of the authority and control which it was agreed New York should have over the waters of New York Bay, we find of necessity that the authority and control of New Jersey were correspondingly limited. It is therefore, as we conceive it, idle to say that New Jersey itself, and the acts which it attempts to authorize, are excepted from the compact. For it is of the essence of the compact that New Jersey itself should not derogate from its own stipulation.

The scope of the exclusive jurisdiction vested in New York over the waters described in Article Third has been the subject of discussion in the courts of both States and in this Court. The language of the compact clearly imports, and we believe it to be established by the decisions, that the jurisdiction of New York over the waters of New York Bay embraces the control over these waters necessary for the protection of health and commerce. New York has exclusive jurisdiction, aside from the authority of Congress, over these waters for police and sanitary purposes.

The entire territory in question was granted originally by Charles the Second to the Duke of York, afterward James the Second. The Duke of York granted to Lord Berkeley and Sir George Carteret the territory now the State of New Jersey and described it as "all that tract of land adjacent to New England and being to the westward of Long Island and Manhattan Island, and bounded

on the east part by the main sea and part by Hudson River, and hath upon the west Delaware bay or river." It is a matter of history that between the date of this grant and the Revolution, the charters of New York City, and the proceedings of its authorities, showed that it had always been claimed that the whole of the Hudson River up to low-water mark on the westerly shore belonged to New York. After the Revolution, the State of New York made the same claim. It appears, however, and the Supreme Court of New Jersey has so stated, that it was only after the Revolution, and when it appeared that if New York's claim was acquiesced in, all the wharves and improvements on the Jersey shore would be subject to the control of New York, that New Jersey claimed that, by conquest from the Crown, the right of New Jersey was extended to the middle of the river (*State* v. *Babcock,* 30 N. J. L., 29, 33). This led to the appointment of commissioners by the two States to settle the conflicting claims in 1807, and again in 1827, but without success. Meanwhile, Judge Washington had decided that the grant to New Jersey limited its territory to the eastern shore of the Delaware river and bay, a decision acknowledged by the New Jersey court to be correct (*State* v. *Davis,* 1 Dutcher, 386). The Supreme Court of New Jersey, speaking by Mr. Justice ELMER, who himself as one of the New Jersey commissioners had negotiated and signed the compact, has thus stated the considerations which led to the final agreement:

> "When the commissioners of New Jersey and New York again met, in 1833, and it was found that those of the latter state appeared to be desirous of arranging the dispute upon fair and liberal terms, but deemed it indispensable that their great commercial emporium should have the exclusive control of the police on the surrounding waters, and full power to establish such quaran-

tine regulations as should be found necessary, the commissioners of this state deemed it wise to secure the exclusive property in the soil to the middle of the river, and exclusive jurisdiction over the wharves, docks and other improvements made or to be made on the Jersey shore, and of the vessels fastened thereto, and the right to regulate the adjacent fisheries, leaving to New York, which was thought to be quite as much a burthen as a privilege, the exclusive jurisdiction over the offences in or upon the waters or the land covered by the water outside of the low-water mark. As it was thought possible that the time might come when Perth Amboy should be an important city, like exclusive jurisdiction over the adjacent waters to low-water mark on Staten Island was secured to this state (New Jersey). Nothing has since occurred to make the propriety of this arrangement doubtful; on the contrary, there is every reason to believe that it has secured important rights to this state, which otherwise might have been lost."

It is plain that there was no thought on the part of either party, in virtually extending to the *filum aquae* the boundary of New Jersey (a title never claimed before the Revolution), that New York should be denied exclusive jurisdiction over the waters described in the compact, for as Mr. Justice ELMER says, it was deemed to be *"indispensable that their great commercial emporium should have the exclusive control of the police on the surrounding waters and full power to establish such quarantine regulations as should be found necessary."*

In *State* v. *Babcock* (30 N. J. L., 29), an indictment was found in Hudson County, New Jersey, for a nuisance in obstructing the Hudson River. There had been a verdict of guilty, but the Supreme Court of New Jersey ordered a new trial. It was held that an indictment would lie in New Jersey for a nuisance in obstructing the Hudson River by placing vessels and wrecks on the shore between the high and low water lines, but not for placing

them below the low water line. If they were below the low water line, exclusive jurisdiction was held to be in the State of New York, according to the compact, although the nuisance was created on the New Jersey side of the boundary in the middle of the stream. The Court said:

> "The waters of the Hudson, although exclusively within the jurisdiction of New York, are a common highway for all the citizens of the United States. Any obstruction to that highway, placed on the shore above low water mark, which shore remains exclusively within the jurisdiction of New Jersey, either by means of vessels, logs, stones, or other temporary obstructions placed there, or by means of a wharf or other improvements which are injurious to navigation, is of course indictable in this state; while obstructions below the low water mark where not only the water but the land under the water are exclusively, except as to the fisheries, within the jurisdiction of New York, can only be punished by proceedings in the courts of that state or of the United States. * * *
>
> "The indictment in the case before us charges that the defendants obstructed the free navigation of the river, by placing, sinking and lodging in said river, and upon the shore of this state in said river, certain ships, schooners, boats, and other vessels; and it is found as a fact by the jury, according to the special case returned to us with a general verdict of guilty, that the defendants had, within the time specified in the indictment, placed and procured to be placed vessels and wrecks of vessels, both above and below the low water line, which were an interruption to the free navigation of the river. Other facts are also found by the jury, which perhaps were meant to show that obstructions were placed in a dock; but the indictment does not charge that any obstructions were placed in a dock, nor do the facts stated enable us judicially to determine that such was the case. What is a dock, I suppose is a mixed question of fact and law.

"Had the special case explicitly stated that the obstructions placed on the shore, that is on the land covered by the tide between the ordinary high and low water lines, were obstructions to the navigation of the river, and did it sufficiently appear that the two defendants had acted jointly in placing and keeping them there, I should be of opinion that judgment ought to be pronounced for the state. As the case appears, it will be the only safe course to send down the case for a new trial, that these two questions may be distinctly submitted to the jury.

"It has been earnestly insisted that the safety of property holders on the Jersey shore requires us to hold that obstructions in the river, outside of the low water line, if injurious to the navigation of vessels coming to that shore, are offences against our laws and indictable in our courts. But apprehensions of this kind, which are probably altogether imaginary, will not justify us in departing from the plain meaning of the compact. Although, for some purposes, New Jersey is bounded by the middle of the Hudson River, and the State owns the land under the water to that extent, exclusive jurisdiction, not only over the water, but over the land to the low water line on the Jersey shore, is in plain and unmistakable language, granted to, or rather acknowledged to belong to the State of New York. There is no reason to doubt that the tribunals of that State, which have a common interest in preventing all obstructions to the navigation of the waters surrounding their most important city, will not only punish all crimes against our citizens or their own, while in or upon those waters, but will also adequately punish all interference with the navigation. The case does not materially differ from a line between two states on the land which happens to be the scene of a busy population, where a manufactory near to that line, in one state, may be a nuisance to the citizens of the other, whose redress will have to be obtained from the tribunals of the state in which the nuisance is situate."

In *People* v. *Central R. R. Co. of New Jersey*, 42 N. Y., 283, the action was brought by the Attorney-General of New York to abate as nuisances certain wharves, bulkhead, piers, etc., which were built into the Hudson River from the New Jersey shore. The Court of Appeals decided that these were structures within the qualifying provision of subdivision 2 of Article Third of the compact to the effect that New Jersey should have exclusive jurisdiction of "the wharves, docks and improvements made, and to be made, on the shore of the said State, etc." It was accordingly held that the suit could not be maintained.

Reciting the history of the compact, the Court observed that the commissioners doubtless considered that under the authority to agree respecting *"the jurisdiction between these States"* they were authorized *"to agree upon and determine the mode in which the said States should exercise, use and enjoy their respective rights into and upon, and over the waters of the said river and bay,* through the center of which they had just, in said first article, run an imaginary line, fixing the boundary between said States, and how the vast domestic and foreign commerce, which then covered, and was destined in the future to crowd and cover these waters, might be best protected, controlled and governed, without conflict between the authorities of said States, or between the citizens thereof." And the Court added:

> "It is quite apparent, I think, that they well and wisely considered that the necessities of the case, the welfare of these States, the exigencies of commerce, and the interests of the city and port of New York in particular, in whose prosperity, as the commercial metropolis of the country, New Jersey had, in a large degree, a common interest, required that there should be a unity of control over said waters, and a single and exclusive jurisdiction exercised over them by one of the said States. And

> this control or *jurisdiction*, in the language used in that treaty or agreement, was very properly conceded to this State in the following article." (Article Third) * * * This provision in the treaty most clearly and distinctly gives and grants to, and vests in the State of New York, full, complete and undoubted control, government and jurisdiction of and over all the waters therein mentioned. Such was the clear intent and purpose of this provision; and, so far as it was essential to the proper exercise of such jurisdiction, it gives a control also of and over the land covered by such waters. It doubtless was designed in the clause of said provision in these words: 'Of and over the lands covered by the said waters to low water mark,' to disembarrass the jurisdiction so conferred over the said water, from all pretense of right to interfere therewith arising from the legal maxim that the owner of the soil owned all above it, '*cujus est solum, ejus est usque ad coelum.*' So that the jurisdiction over the *water* should be absolute and unquestioned for all practical purposes." (*Id.* pp. 295, 296.)

But while it was clear that it was the intention to establish this unity of control over the waters in question, and to vest that control in the State of New York, it was pointed out that by the provisions of the first article, and of the subdivisions with respect to the rights of New Jersey contained in the third article, it was intended that New Jersey should have complete jurisdiction over the whole subject of wharves and docks on the Jersey shore. It was added that the word "shore" was obviously used "in a general sense, as equivalent to side or margin of the river and bay, and not in the strict sense as applicable to the particular space between high and low water mark, as is its meaning when applied to the land at the edge or border of the sea or arm of the sea where the tide ebbs and flows." It could not be supposed that the wharves and docks referred to were to be built remote from the water or above low water mark, and it was contemplated that they would

be constructed below low water mark and would extend sufficiently into the deep water of the river or bay to answer the ordinary purposes for which such erection was made. (*Id.* pp. 298, 299.)

While, then, it was concluded that the wharves, bulkhead, piers, etc., in question, built out from the New Jersey shore, were within the jurisdiction of New Jersey, the decision fully recognized the jurisdiction of the State of New York over the waters of the river and bay, for police and sanitary purposes, and that this jurisdiction was vested in New York to establish a unity of control for the protection of health and commerce.

That this jurisdiction extended to the prevention of injurious deposits in the waters of the bay was decided in *Ferguson* v. *Ross* (126 N. Y., 459). The action was brought in New York to recover a penalty under a New York statute for the prevention of the deposit of "carrion, offal or dead animals in the North and East Rivers or in the Bay of New York or Raritan Bay, within the jurisdiction of the State of New York." The shore inspector had instituted the action against the defendant for discharging dredgings "into the waters of the river opposite the City of New York, on the New Jersey side, at a point about one-fourth of a mile from the New Jersey shore" (*Id.*, p. 462). It was insisted that the deposit having been made within the territorial limits of New Jersey the State of New York had no jurisdiction. The Court of Appeals held that the decision in *People* v. *Central Railroad Company of New Jersey, supra*, furnished a satisfactory answer, and that "the purpose of investing exclusive jurisdiction over these waters, in the State of New York, was to promote the interests of commerce and navigation, which would, as supposed, be best subserved by giving to this State the exclusive control and regulation of the waters of the bay and harbor of New York (*Id.*, p. 463). Accordingly a judgment for the penalty was affirmed.

It thus appears that the Courts of New Jersey (*State* v. *Babcock, supra*), and the Courts of New York (*Ferguson* v. *Ross, supra*), are in entire accord with respect to the exclusive control (as between these States) vested by the compact in the State of New York over the waters of the river and bay for the purpose of preventing either obstructions to navigation (apart from wharves, docks or improvements appurtenant to the New Jersey shore), or injurious deposits menacing health or commerce.

In *Central Railroad of New Jersey* v. *Jersey City* (70 N. J. L., 81) there was a writ to review taxes levied by Jersey City upon lands of the railroad company between the middle of New York Bay and the low water line on the New Jersey shore. The right to New Jersey to tax these lands was sustained. The sovereignty of New Jersey and its taxing power were held to be co-extensive with its territorial limits as established by the compact. But so far from detracting from the previously accepted purpose of the compact in vesting exclusive jurisdiction in the State of New York, the Supreme Court of New Jersey quoted with approval the decision of the Court of Appeals in *Ferguson* v. *Ross, supra*. And again, instead of disagreeing with the statement with respect to the scope of the authority and control vested in New York, which is found in the opinion of the Supreme Court of New Jersey delivered by Mr. Justice ELMER in *State* v. *Babcock, supra*, the Court cited the opinion as one which was especially important in determining the meaning of the term "jurisdiction" as used in the compact.

This power to tax was upheld on writ of error from this Court in *Central Railroad Company* v. *Jersey City* (209 U. S., 473). In delivering the opinion of this Court, Mr. Justice HOLMES said:

> "Thus the land which has been taxed is on the New Jersey side of the boundary line but under the 'exclusive jurisdiction' of New York, subject to the

> exclusive right of property in New Jersey and the limited jurisdiction and authority conferred by the paragraphs summed up. The question is which of these provisions governs the right to tax. It appears to us plain on the face of the agreement that the dominant fact is the establishment of the boundary line. The boundary line is the line of sovereignty, and the establishment of it is not satisfied but is contradicted by the suggestion that the agreement simply gives the ownership of the land under water on the New Jersey side to that State as a private owner of land lying within the State of New York. On the contrary, the provision as to exclusive right of property in the compact between States is to be taken primarily to refer to ultimate sovereign rights, in pursuance of the settlement of the territorial limits, which was declared to be one purpose of the agreement, and is not to be confined to the assertion and recognition of a private claim, which, for all that appears, may have been inconsistent with titles already accrued and which would lose significance the moment that New Jersey sold the land. We repeat that boundary means sovereignty, since in modern times sovereignty is mainly territorial, unless a different meaning clearly appears."

But in making the distinction between "jurisdiction" and "sovereignty", under the compact, and in sustaining a taxing power co-extensive with territorial limits, there was no impairment of the "exclusive jurisdiction" vested in New York to secure the objects which the Courts both of New York and New Jersey had found to be in view. The fact that New Jersey could tax the land within the boundary was in no way inconsistent with the exclusive control vested in New York for the purpose of adequately protecting the interests of what Mr. Justice ELMER called the "great commercial emporium."

If it be said that New Jersey would not have recognized the exclusive jurisdiction of New York over the waters of the river and bay, if the *filum aquae* had not been taken as

the territorial boundary and New York had not yielded to New Jersey the control over the shore improvements on the Jersey side, it is equally true that New York would not have consented to the fixing of the territorial boundary at a place where it was never claimed to exist prior to the Revolution, if New Jersey had not consented to the exercise by New York of exclusive jurisdiction over the waters of the river and bay for the protection of the commerce of the harbor and of the health and prosperity of the City of New York. Instead of dividing control over these waters, it was unified and the single control placed in the State of New York. We are not dealing here with shore improvements by New Jersey, nor with New Jersey's power to tax, but with New York's right to insist that this concentrated mass of filth collected from numerous municipalities in the Passaic Valley should not be discharged into the waters of the bay.

If control for police and sanitary purposes of the waters of the bay means anything, it means control to prevent pollution of this character; if New York's exclusive jurisdiction to protect health and commerce means anything, it means the right in a case of this description to prevent an intolerable nuisance at its very door.

It is urged that jurisdiction implies the power to establish regulations, and that New York has not established regulations which are pertinent to this matter. But the contrary is the fact.

Section 75 of the Public Health Law of New York, as added by Laws of 1903, Chapter 468 (now found in Public Health Law, Section 76) provides:

> "Section 75. DISCHARGE OF SEWAGE AND OTHER REFUSE MATTER INTO CERTAIN WATERS PROHIBITED. —No person, corporation or municipality, shall place or cause to be placed, or discharge or cause to be discharged into any of the waters of this state,

unless the same shall have been permitted by the state commissioner of health, any sewage, garbage, offal, dead animal, dead fish, dead bird or part thereof, or any decomposable or putrescible matter of any kind or any substance, chemical or otherwise, containing the same in quantities injurious to the public health, or any refuse or waste matter, either solid or liquid, in quantities injurious to the public health, from any shop, factory, mill or industrial establishment; unless express permission to do so shall have been first given in writing by the state commissioner of health as provided in this article, except as hereinafter provided. But this section shall not prevent the discharge of sewage from any public sewer system owned and maintained by a municipality, or the discharge of refuse or waste matter from any shop, factory, mill or industrial establishment, provided such sewer system was in operation and was discharging sewage, or such shop, factory, mill or industrial establishment was in operation and discharging refuse or waste matter, into any of the waters of this state on or prior to May seventh, nineteen hundred and three, nor to any extension or modification of such shop, factory, mill or industrial establishment or reconstruction thereof, provided the refuse or waste matter discharged therefrom is not materially changed or increased; but this exception shall not permit any increase in the discharge of such sewage, nor shall it permit the discharge of sewage from a sewer system which shall be extended, modified or reconstructed subsequent to said date."

It has been said by defendants' counsel that this statute has no application, as by its terms it applies only to the waters of the State of New York. But the waters in question are the waters of the State of New York. They have always been regarded from Colonial times as the waters of the State of New York, and it was for this reason and to establish appropriate unity of control that exclusive

jurisdiction was reserved over these waters when the compact was made with New Jersey in 1833. There can be no question but what New York under this reservation of exclusive jurisdiction had the authority to enact legislation of this description with respect to the waters of New York Bay at the place in question. It is not to be assumed that New York did not in this legislation exercise the authority which it was entitled to exercise. Had the language of the Act been "any of the waters under the jurisdiction of this State," we apprehend that no such contention would be made. But as New York has, as against New Jersey, (that is, apart from appropriate Federal action) the exclusive right to legislate for the protection of these waters in the matter of police and sanitation, we can conceive of no reason why the words of the statute "any of the waters of this State" should be taken to exclude these waters, when the words "any of the waters subject to the jurisdiction of this State" would manifestly have included them. It is true that the statute has not, in this respect, been judicially construed, but New York State is here by its Attorney-General asserting that the statute does apply to the waters in question. This was alleged in the bill brought by the State of New York, and a copy of the statute in question was annexed to the bill. This assertion of the scope of the statute has never been contravened by any competent authority. It cannot be said that New York fails to maintain its standing because it has not legislated, for in fact it has legislated; or that the legislation is inapplicable, for the words are sufficient to cover the case and from the outset they have been treated by New York as covering the case.

We do not, however, concede that legislation is necessary to enable New York to maintain its rights under the compact as against New Jersey with respect to this pollution of the waters of the Bay. Legislation in such a case

is not the sole resource. The act here in question was performed by New Jersey itself through her official agency. We cannot bring the State of New Jersey to the bar of the New York courts; but if New Jersey is doing the thing which under the compact New York is entitled to prevent, then we submit that under the compact New York has a standing in this suit to invoke the restraining power of this Court against the commission of the act.

The circumstance that the tunnel or trunk sewer is attached to the soil of New Jersey can make no difference. It is not the mere structure attached to the soil of which New York complains. New York objects to the pouring into the waters of the bay of this mass of filth conducted by the tunnel from the municipalities of the Passaic Valley. Suppose that, instead of using the tunnel, or a trunk sewer, attached to its soil, officers of New Jersey collected the same sewage and brought it in floats to the point of discharge and there dumped it into the waters of the bay. It would seem to be clear that New York would be entitled to object. *Ferguson* v. *Ross* (*supra*), the doctrine of which has been acquiesced in by New Jersey, would be ample authority for that proposition. But if New York would be entitled to prevent such action, we submit that the State loses none of her rights because New Jersey has built a tunnel for the same purpose. The manner of conducting the sewage to the point of discharge does not affect the question.

The defendants have referred to the case of *Sayre* v. *Newark*, 60 N. J. Eq., 361, to the effect that, under the constitutional system of New Jersey, the Legislature has authority to authorize municipalities to use tidal streams within the borders of the State as outlets for public sewers. The decision had reference to the charter of the City of Newark, which granted to the municipal authorities the

right to use the Passaic River as such an outlet. But this decision has no application to a case arising under the compact of 1833. The sovereignty of New Jersey in dealing with its municipalities is one thing; its authority to collect sewage from distant municipalities and transfer the collected mass to a point of discharge in these waters, which are under the control of New York for the protection of health and commerce, is quite another.

We conclude, therefore, that whether the Court has regard to the standing of the State in its quasi-sovereign capacity, and to those principles which govern the determination of controversies between States, or to the terms of the compact with New Jersey which expressly vests in the State of New York exclusive jurisdiction over these waters for the protection of health and commerce, the State of New York is entitled to maintain this bill, and its allegations as to the menace to its essential interests having been fully sustained by the proof, we ask that a decree be entered in its favor.

Respectfully submitted,

MERTON E. LEWIS,
Attorney-General of the State of New York,
For Complainants.

CHARLES E. HUGHES,
WILLIAM J. O'SULLIVAN,
of Counsel.

APPENDIX.

"Chap. CXXVI.—An Act giving the consent of Congress to an agreement or compact entered into between the state of New York and the state of New Jersey, respecting the territorial limits and jurisdiction of said states.

WHEREAS, commissioners duly appointed on the part of the state of New York, and commissioners duly appointed on the part of the state of New Jersey, for the purpose of agreeing upon and settling the jurisdiction and territorial limits of the two states, have executed certain articles, which are contained in the words following, viz.:

Agreement made and entered into by and between Benjamin F. Butler, Peter Augustus Jay and Henry Seymour, commissioners duly appointed on the part and behalf of the state of New York, in pursuance of an act of the legislature of the said state, entitled 'An act concerning the territorial limits and jurisdiction of the state of New York and the state of New Jersey, passed January 18th, 1833, of the one part; and Theodore Frelinghuysen, James Parker and Lucius Q. C. Elmer, commissioners duly appointed on the part and behalf of the state of New Jersey, in pursuance of an act of the legislature of the said state, entitled 'An act for the settlement of the territorial limits and jurisdiction between the states of New Jersey and New York,' passed February 6th, 1833, of the other part.

ARTICLE FIRST. The boundary line between the two states of New York and New Jersey, from a point in the middle of Hudson river, opposite the point on the west shore thereof, in the forty-first degree of north latitude, as heretofore ascertained and marked, to the main sea, shall be the middle of the said river, of the bay of New York, of the waters between Staten Island and New Jersey, and of Raritan bay, to the main sea; except as hereinafter otherwise particularly mentioned.

ARTICLE SECOND. The state of New York shall retain its present jurisdiction of and over Bedlow's and Ellis islands; and shall also retain exclusive jurisdiction of and over the other islands lying in the waters above mentioned and now under the jurisdiction of that state.

ARTICLE THIRD. The state of New York shall have and enjoy exclusive jurisdiction of and over all the waters of the bay of New York; and of and over all the waters of Hudson river lying west of Manhattan Island and to the south of the mouth of Spuytenduyvel creek; and of and over the lands covered by the said waters to the low water-mark on the westerly or New Jersey side thereof; subject to the following rights of property and of jurisdiction of the state of New Jersey, that is to say:

1. The state of New Jersey shall have the exclusive right of property in and to the land under water lying west of the middle of the bay of New York, and west of the middle of that part of the Hudson river which lies between Manhattan Island and New Jersey.

2. The state of New Jersey shall have the exclusive jurisdiction of and over the wharves, docks and improvements made and to be made on the shore of the said state; and of and over all vessels aground on said shore, or fastened to any such wharf or dock; except that the said vessels shall be subject to the quarantine or health laws, and laws in relation to passengers, of the state of New York, which now exist or which may hereafter be passed.

3. The state of New Jersey shall have the exclusive right of regulating the fisheries on the westerly side of the middle of the said waters, *Provided*, That the navigation be not obstructed or hindered.

ARTICLE FOURTH. The state of New York shall have exclusive jurisdiction of and over the waters of the Kill Van Kull between Staten Island and New Jersey to the westernmost end of Shooter's

Island in respect to such quarantine laws, and laws relating to passengers, as now exist or may hereafter be passed under the authority of that state, and for executing the same; and the said state shall also have exclusive jurisdiction for the like purposes of and over the waters of the sound from the westernmost end of Shooter's Island to Woodbridge creek, as to all vessels bound to any port in the said state of New York.

ARTICLE FIFTH. The state of New Jersey shall have and enjoy exclusive jurisdiction of and over all the waters of the soand between Staten Island and New Jersey lying south of Woodbridge creek, and of and over all the waters of Raritan bay lying westward of a line drawn from the lighthouse at Prince's bay to the mouth of Mattavan creek; subject to the following rights of property and of jurisdiction of the state of New York, that is to say:

1. The state of New York shall have the exclusive right of property in and to the land under water lying between the middle of the said waters and Staten Island.

2. The state of New York shall have the exclusive jurisdiction of and over the wharves, docks and improvements made and to be made on the shore of Staten Island, and of and over all vessels aground on said shore, or fastened to any such wharf or dock; except that the said vessels shall be subject to the quarantine or health laws, and laws in relation to passengers of the state of New Jersey, which now exist or which may hereafter be passed.

3. The state of New York shall have the exclusive right of regulating the fisheries between the shore of Staten Island and the middle of the said waters: *Provided*, That the navigation of the said waters be not obstructed or hindered.

ARTICLE SIXTH. Criminal process, issued under the authority of the state of New Jersey, against any person accused of an offense committed within

that state; or committed on board of any vessel being under the exclusive jurisdiction of that state as aforesaid; or committed against the regulations made or to be made by that state in relation to the fisheries mentioned in the third article; and also civil process issued under the authority of the state of New Jersey against any person domiciled in that state, or against property taken out of that state to evade the laws thereof; may be served upon any of the said waters within the exclusive jurisdiction of the state of New York, unless such person or property shall be on board a vessel aground upon, or fastened to, the shore of the state of New York, or fastened to a wharf adjoining thereto, or unless such person shall be under arrest, or such property shall be under seizure, by virtue of process or authority of the state of New York.

ARTICLE SEVENTH. Criminal process issued under the authority of the state of New York against any person accused of an offense committed within that state, or committed on board of any vessel being under the exclusive jurisdiction of that state as aforesaid, or committed against the regulations made or to be made by that state in relation to the fisheries mentioned in the fifth article; and also civil process issued under the authority of the state of New York against any person domiciled in that state, or against property taken out of that state, to evade the laws thereof, may be served upon any of the said waters within the exclusive jurisdiction of the state of New Jersey, unless such person or property shall be on board a vessel aground upon or fastened to the shore of the state of New Jersey, or fastened to a wharf adjoining thereto, or unless such person shall be under arrest, or such property shall be under seizure, by virtue of process or authority of the state of New Jersey.

ARTICLE EIGHTH. This agreement shall become binding on the two states when confirmed by the

legislatures thereof, respectively, and when approved by the Congress of the United States.

Done in four parts (two of which are retained by the commissioners of New York, to be delivered to the governor of that state, and the other two of which are retained by the commissioners of New Jersey, to be delivered to the governor of that state), at the city of New York this sixteenth day of September, in the year of our Lord one thousand eight hundred and thirty-three and of the independence of the United States the fifty-eighth.

B. F. Butler,
Peter Augustus Jay,
Henry Seymour,
Theo. Frelinghuysen,
James Parker,
Lucius Q. C. Elmer.

And whereas the said agreement has been confirmed by the legislatures of the said states of New York and New Jersey, respectively,—therefore,

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That the consent of the Congress of the United States is hereby given to the said agreement, and to each and every part and article thereof, *Provided*, That nothing therein contained shall be construed to impair or in any manner affect, any right of jurisdiction of the United States in and over the islands or waters which form the subject of the said agreement.

Approved, June 28, 1834."

SUPREME COURT OF THE UNITED STATES.

No. 2—ORIGINAL.

NEW YORK v. *NEW JERSEY, et al.*

Complainant's Additional References to Record.

Panoramic View.

Complainant's Ex. 217, Vol. III, pp. 2873, 2874.

Profile of Passaic Valley Trunk Sewer.

Complainant's Ex. 127, Vol. V, p. 3995.

Depletion of Oxygen Content of Harbor Waters.

Testimony, *Eddy*, Vol. II, pp. 1467, 1468.
Ellery, Vol. III, pp. 2025-2028.
Phelps, Vol. III, p. 2735.

Report of *Black & Phelps*, Vol. V, p. 4017 *et seq.*
Complainant's Ex. 97, Vol. IV, p. 3778 *et seq.*
" " 99, Vol. V, p. 3897 *et seq.*
" " 150-156, Vol. V, p. 4265 *et seq.*
" " 159-169, Vol. V, p. 4313 *et seq.*

Volume of Sewage from Passaic Valley District.

Population, number of municipalities, etc., Vol. I, p. 56; Vol. II, pp. 1282, 1296.

Consequences of Passaic Valley Sewerage Project.

Testimony, *Sedgwick*, Vol. III, p. 2812.
Griffin (Supt. of Water Works, Jersey City, Vol. III, 2873, 2875.

Question before Harbor Line Board simply as to obstruction of navigation.

Remarks of *Col. Lockwood* (Chairman), Vol. IV, p. 2959.
Col. Knight, Vol. IV, p. 2978.

Difference between
Conditions in Potomac River and those in New York Bay, Vol. III, p. 2808.
Conditions in Boston Harbor and New York Bay, Vol. III, pp. 2809-2811.

Conditions in Bronx Valley Sewerage District.
Population, etc.
Testimony, *Hill*, Vol. III, p. 2158.
Landreth, Vol. III, pp. 2098, 2109, 2126.

Stipulation as to Bronx Valley Sewerage.
Complainant's Ex. 177, Vol. V, p. 4317.

DEC 4 1920

Supreme Court of the United States,

OCTOBER TERM—1920,

No. 2 ORIGINAL.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainant,
against
THE STATE OF NEW JERSEY and PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

Now comes the complainant and states that the additional testimony herein permitted to be taken pursuant to the order of this Court dated March 10, 1919, has been taken and printed, and the cause is now ready for hearing, and the complainant asks that the cause be set down for hearing at such time as may suit the convenience of the Court.

Dated, November 24, 1920.

CHARLES D. NEWTON,
Attorney General of the State of New York, Solicitor for Complainant.

WILLIAM J. O'SULLIVAN,
Solicitor and of Counsel for Complainant.

CHARLES E. HUGHES,
Special Counsel for Complainant.

RUSSELL LORD TARBOX,
Special Counsel for Complainant.

The undersigned concur in the above request that this cause be set down for hearing and consent that an application therefor may be made by the complainant to this Court on December 6, 1920, or on any later motion day, without further notice.

THOMAS F. McCRAN,
Attorney General of the State of New Jersey, Solicitor for Defendant, The State of New Jersey.

ADRIAN RIKER,
Solicitor for Defendant, Passaic Valley Sewerage Commissioners.

ROBERT H. McCARTER,
Special Counsel for Defendants.

JAN 24
JAMES B. BAKER

No. 2 Original

In the Supreme Court of the United States

October Term, 1920

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,

vs.

THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

BRIEF ON BEHALF OF THE DEFENDANTS

THOMAS F. McCRAN,
Attorney General of the State of New Jersey.

ADRIAN RIKER,
Counsel, Passaic Valley Sewerage Commissioners.

GEORGE W. WICKERSHAM,
ROBERT H. McCARTER,
of Counsel.

Ingle, Inc., 165 William Street.

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No. 2 Original

IN THE

Supreme Court of the United States

October Term, 1920.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainant,

vs.

THE STATE OF NEW JERSEY and PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

SUPPLEMENTAL BRIEF AND ARGUMENT FOR DEFENDANTS ON THE COMING IN OF ADDITIONAL TESTIMONY UNDER ORDER OF MARCH 10TH, 1919.

It is our purpose in this supplemental brief to confine our discussion to the additional testimony taken under the order of March 10th, 1919, excepting insofar as it may be necessary to refer to the original testimony for explanation of the additional testimony or to answer the arguments of complainant's supplemental brief. For a discussion of the law and of the evidence produced upon the original hearing we respectfully refer this Honorable Court to our original brief.

We remind the Court that complainant's prayer for injunction against the construction and operation of the Passaic Valley sewer is based upon two charges:

(1) That there will be set up at the point of discharge of this sewer a local nuisance injurious to complainant by the establishment of vast sewage and sleek fields in the waters of Upper New York Bay, which will be so offensive to sight and smell as to constitute a positive

nuisance, extending to and affecting the State of New York and its inhabitants.

(2) That by discharging into the waters of Upper New York Bay organic matter contained in the sewage effluent, so great a demand will be made upon the sewage digestive capacity of those waters, consisting of the dissolved oxygen therein, that a local nuisance will be created along the water fronts of New York, Brooklyn, and other parts of the City of Greater New York.

To these charges we reply that on the evidence as it now stands the conclusions must be, (1) that no local nuisance will be directly caused at the point of discharge of the sewer in the waters of the Upper Bay of New York; (2) that no general nuisance will be indirectly caused in the waters of the Upper Bay of New York which does not now in fact exist through the acts of complainant's agent, the City of New York, and which must be abated independently of the existence or non-existence of the Passaic Valley sewer.

I.

That no local nuisance will be directly caused by the effluent from the Passaic Valley sewage at the point of discharge.

That no local nuisance will be directly caused at the point of discharge will appear from these considerations:

(a) The dispersion area consisting of three and one-half acres of land within which the sewage effluent from the Passaic Valley sewer will be discharged, is entirely within the limits of the State of New Jersey.

(b) The presumption of self-interest precludes the possibility of defendants setting up a nuisance in the waters of the Upper New York Bay at the

dispersion area, (1) because the great future of New Jersey's water front on Upper New York Bay makes it inconceivable that a nuisance should be allowed, not to say promoted, by the State which should menace that future; (2) because the stipulation entered into with the United States in this cause (Exhibit C, 135), and whose provisions are embodied as conditions to the maintenance of its structures under the waters of New York Bay in the Permits granted by the Secretary of War (Defts.' Exhibits 6-7), is declared by every witness examined upon the subject, whether produced by complainant or defendants, to exclude the possibility of setting up a local nuisance if the terms are complied with, and therefore can only be disregarded by presuming it to be unenforceable by the sovereign power of the United States and fraudulent on the part of the defendants; (3) because the appropriation and expenditure of eleven and one-quarter million dollars, now increased to fifteen and one-half million dolllars and later to be increased by the further sum of four million dollars in the construction of its sewage disposal plant, would be criminally reckless and foolhardy on the part of the defendants.

(c) The sanctions for undertaking of the work under the stipulation above referred to are convincing and specific:

1. Findings of the Harbor Line Board embodied in the stipulation with the United States (C. 135), were those of expert army engineers sitting in a judicial capacity, unbiased and entitled to full faith and confidence, and were accepted by the defendants as such and adopted by the law department of the United States as sufficient to justify it in withdrawing from this suit. We submit, they are entitled to the highest consideration by this Honorable Court.

2. The opinions and recommendations of Rudolph Hering, George W. Fuller and Edlow W. Harrison, contained in Complainant's Exhibit D. 5, were in fact relied upon by Passaic Valley Sewerage Commissioners and are also entitled to the highest consideration.

(a) These eminent engineers were not partisan witnesses in a litigated matter.

(b) In making their report (D. 5), they assumed the responsibility of inducing the defendants, Passaic Valley Sewerage Commissioners, to enter upon an expenditure, then estimated at eleven and one-quarter million dollars, under the limitations contained in the stipulation (C. 135), and therefore predicated upon the absence of any kind of nuisance in the waters of the Upper New York Bay due to the operation of the Passaic Valley sewer.

(c) The opinions of defendants' expert witnesses are unanimous that no local nuisance will be caused in the waters of Upper New York Bay by the discharge of the effluent of the Passaic Valley sewage at or near Robbins Reef at the depth, by the outlets and under the conditions described in the stipulation. Unquestionably these opinions are subject to the general criticisms of expert testimony that partisan bias may have prompted them. The real test of value of expert testimony is the application to it of specific facts to sustain and confirm them. The evidence in this case establishes:

A. That the resultant of the Passaic Valley sewage after treatment and dilution in the deep waters of the Upper New York Bay will be a mix-

ture of less than five parts of solid matter in one million parts of water.

B. That the discharge of the effluent from the Passaic Valley sewage at the depth of over forty feet and in the manner prescribed by the stipulation will result in the equalizing of the temperatures and the water of the Bay and thus prevent the rising to the surface of the highly diluted mixture.

C. That the action of the tides and currents will disperse the diluted mixture and prevent the establishment of any trace of sewage or sleek field over the dispersion area.

D. That the results of actual experience in the discharge at considerable depth of sewage very much less clarified than the effluent of the Passaic Valley Sewerage Works demonstrates the soundness of opinions of defendants' experts witnesses. Thus,

(a) Conditions existing in the Potomac River at Washington described by Asa Henry Phelps and particularly referred to in defendants' original brief, p. 21, demonstrate the effectiveness of deep water discharge upon sewage treated only by screening and not at all sedimented;

(b) Conditions resulting from the installation of multiple outlets in waters at the Deer Island outlet of the Metropolitan Sewage Works at Boston Harbor and the discharge therefrom of a much less clarified effluent support the same conclusion, and

(c) The plans of the City of New York for the disposal of part of its sewage recommend the same system.

(d) The testimony of complainant's witnesses, Kenneth Allen and Professor Landreth, further sustain the opinions of defendants' experts. Thus:

(1) The plans of the City of New York for the abatement of the polluted conditions now existing in the East River call for the intercepting of the sewers now discharging along the Brooklyn shore, the transporting of the sewage to a proposed artificial island off Red Hook at a point a little below Governors Island and at the entrance to Buttermilk Channel, at least a mile nearer the shores of Brooklyn than Robbins Reef, the treatment of this sewage by screening and sedimentation and the discharging of the effluent to the amount of two hundred million gallons per day by multiple outlets into the main ship channel at a depth of about forty feet. It is hardly to be assumed that the City of New York, in the face of its opposition to the Passaic Valley sewer's discharge into the same ship channel, would deliberately adopt plans for the establishment of a local nuisance nearer to its own shores and only a short distance from Governors Island. It seems, therefore, fair to assume that no nuisance was in fact considered possible by the authorities of the City of New York.

(2) The implication involved in the adoption of the plan for the Red Hook disposal plant is confirmed by the explicit admission of Kenneth Allen, a witness for complainant, who was asked (Additional Test., p. 493): "Will the discharge of two hundred million gallons of sewage treated by screening and sedimentation at or near Red Hook produce a local nuisance, in your opinion? A. That

will depend on the condition of the Upper Bay at the time. I cannot say. Q. In the condition of the Upper Bay at present, will that produce it? A. No."

Professor Landreth also testifies (Additional Test., p. 627):

"Q. If 200,000,000 gallons a day of sewage were diverted from the Brooklyn sewers and discharged off Red Hook and subjected to the processes of screening and sedimentation, will a nuisance be created at that point?

A. Under the plan of interception and screening I do not think there will."

It will be seen from a consideration of the foregoing matters that there is no justification for the charge repeated again and again by complainant throughout the hearing, on the original argument of the case and in the briefs filed on its behalf, that the Passaic Valley Sewerage Commissioners contemplate discharging into the waters of Upper New York Bay a mass of septic filth or to create an intolerable nuisance in those waters, or to transfer to those waters the nuisance admittedly existing in the Passaic River from its mouth up to the City of Paterson. Conditions existing in the Passaic River are the accumulated result of more than twenty years of sewage discharge into the river without treatment of any kind. The river itself is shallow, the water shed is comparatively small, the dry weather flow is insignificant, the pollution producing sewage is steadily increasing and the result now is that it has become in fact an elongated septic tank, the bottom and sides of which are covered by sedimented sludge containing putrefying organic matter. The liquid content is devoid of oxygen, thick and putrid, unsightly to the eye and giving forth noxious odors. In its winding course through the City of Newark, there is little or no current, and in the Summer months particularly, and probably throughout the whole year, there is a con-

stantly increasing accumulation of organic matter multiplying the objectionable conditions from month to month and year to year.

What *is* contemplated by defendant, the Passaic Valley Sewerage Commissioners, is the intercepting of the sewage which now discharges into the Passaic River, the leading of it by a trunk sewer and branches to treatment works on the Newark Meadows, to there clarify it and discharge the effluent through a tunnel into the deep waters of New York Bay on the side of the main ship channel near Robbins Reef at a depth of over forty feet, by one hundred and fifty outlets, distributed over a dispersion area of not less than three and one-half acres. How far the result of this plan will be from conditions predicted by complainant's witnesses will be manifest from consideration of the evidence of Professor Winslow, one of complainant's witnesses (Original Case, p. 1642), who says:

> "Sewage may, perhaps, best be defined as the liquid waste of human life. * * * After all, however, it is mostly water. * * * Fresh sewage looks very much like the dirty water in a wash bowl, being somewhat milky in appearance and not particularly offensive either to sight or smell."

He further says:

> "On an average, American sewage will contain perhaps 800 parts of solid matter in a million parts of water. Of these 800 parts about 300 consist of mineral matter in solution, including substances like common salt. This portion of the sewage has little practical significance. About 100 parts consist of mineral matter in suspension, largely sand and gravel from street washings. The other 400 parts of solid matter are organic in nature and it is these which furnish the serious problems of sewage purification. About 240 parts are in solution and 160 are in suspension as floating matter."

George W. Fuller, testifying for the defendants (Additional Test., p. 46), says:

> "So far as eliminating the visible suspended matter that dilution is a factor, that this sewage as it leaves these tanks will have enough suspended matter in it so you will get the appearance of a liquid that isn't perfectly clear. That is true, but the dilution of a certain fold will eliminate that so you cannot see it. That dilution, whether it is twenty or thirty times, will be readily secured in New York Bay."

Being asked the question, Will the waters of New York Bay cause those visible suspended particles to disappear? he says:

> "By dilution below the point of ready detection by the eye. Let me explain what I had in mind: Take ordinary sewage from an industrial valley and pass it through sedimentation tanks, I presume that in a general way you would say that the remaining suspended particles, representing the difference between the sixty and one hundred per cent., would be say forty per cent.; that forty per cent. of the solids remaining might be one hundred parts per million or one hundred and twenty-five parts per million. That seen in a bottle would indicate a lack of transparency; it would be visible. If you dilute that down, so that the suspended particles would be six or eight parts or less, I don't think it would be discernible. I speak of that, based on my common experience in a good many purification plants, as a practical operating man; you get the turbidity or suspended particles below seven or five parts per million, or thereabouts, it is considered clear water, no visible suspended matter. That is the reasoning that I am using in giving a ratio which shows the need of a diluting factor to bring you from 100 parts down to 5 parts" (Additional Test., p. 47).

The foundation upon which the experts have testified that no local nuisance will in fact be caused at the dispersion point and the reason for the confidence of the defendants that the conditions set forth in the stipulation with the United States of America and upon which the permit by the Secretary of War was granted were capable of being complied with, is thus demonstrated. It does not in fact need an expert to reach the conclusion that a mixture consisting of five parts of solid matter and one million parts of water cannot possibly with accuracy be termed "an intolerable nuisance," or "a mass of septic filth," or be able to produce under any conditions an intolerable nuisance in the waters of New York Bay. In the event that the considerations herein before discussed prove to be fallacious and the results prescribed in the stipulation with the United States are not in fact produced by the discharge of the effluent from the Passaic Valley sewage into the waters of Upper New York Bay, we come to the first of the subjects specified in the order of March 10, 1919, upon which testimony was to be and has been taken, which is as follows:

II.

That there are practical modifications of the proposed system of sewage disposal of the Passaic Valley Sewerage Commissioners, which might be added thereto or introduced therein in case the system as planned should not produce the stipulated results.

> "As to practical modifications of the proposed system of sewage disposal of the Passaic Valley Sewerage Commissioners whether as to construction, arrangement or operation, and the nature and character of sanitary or engineering appliances that may be added thereto or introduced therein, in order to lessen the alleged polluting effect upon the waters of New York Harbor."

George W. Fuller, one of the three witnesses produced by the defendants, summarizes his testimony in the following opinion:

> "The works as being built will give a performance substantially in conformity to that called for by the stipulation" and "the total suspended matter is the sewage would be removed to the extent of fifty to sixty per cent. on an average. The removal of organic matter from the sewage would be from twenty-five to thirty per cent."

If the result so anticipated by him should not in fact be obtained by the works under construction, he suggests modifications in the proposed system as to construction, arrangement and operation thereof as follows:

1. The modification of the plan of the sedimentation basin under which the velocities of flow would be reduced two-thirds below that set forth in the stipulation. As to the consequence of this change he testifies (Additional Test., p. 12), as follows:

> "I think under these circumstances, taking the sewage for one-third of the distance of travel at

also one-third of the velocity, there would then be no opportunity for doubt as to removing say sixty per cent. of total suspended matter and about thirty per cent. of the total organic matter as the record day in and day out."

He further says (Additional Test., p. 12):

"I should make it plain that they will contain scum boards or baffles extending beneath the surface of the liquid, in order to retain scum, floating matters, grease and the like."

He further says on the same page:

"Those changes I should estimate could be installed for the complete set of units now in process of erection for a sum ranging from $100,000 to $150,000."

2. He next recommends (Additional Test., p. 12):

"The treatment of the sewage in the tanks might, if it should be found necessary, be supplemented by the installation of very fine screens or strainers placed in the effluent water ways through which the sewage would pass from the tanks to the tunnel leading to New York Bay."

"Under all ordinary circumstances, I believe that scum boards would retain the floating matter, but it is a fact that tanks with ordinary operating schedules for cleansing, sometimes show in very hot weather a tendency for the sludge to be lifted by gas.

"It is practicable, if need be, to install very fine screens to guard against the passage in New York Bay of gas lifted particles of sludge from the bottom of the sedimentation basins. In other words, the fine screens would be guarding against the accidental or abnormal phase of tank performance, and not the normal or regular performance."

3. He next recommends (Additional Test., p. 13) as an additional operating change:

> "I have considered the question of guarding against the putrefaction condition which might arise during very hot weather in the sewage as it reaches the pumping station and sedimentation basins on the Newark meadows. In addition to the question of guarding carefully against permitting stranded solids to accumulate in the sewers, I am of the opinion that aid might also be secured by blowing air into the sewage at one or more points along its line of travel from Paterson to the pumping station on the Newark Meadows. I estimated that an electrically driven blower might be installed with pipes at or near the city line at a cost of say $30,000 in round numbers. It would also be possible to aerate the sewage again at the basins on Newark Meadows, and as the years go by and if occasion arises, aeration could be installed also at intermediate points, perhaps below Passaic and in the northern limits of the City of Newark. I do not contemplate that such intermediate aeration would be required for a long number of years. What I meant to say was, the use of air for preserving the sewage against putrefaction could be utilized in a practical way to such an extent as actual experience found necessary, as the years go by."

4. He further recommends (Additional Test., p. 13):

> "One other feature I should mention for better operating conditions, and that is the variation in the rate of pumping sewage from the trunk sewer into the basin from whence it will flow by gravity to New York Harbor. If at certain intervals durings the day the sewage was pumped at say one-half the ordinary speed, and at the other intervals correspondingly greater increase above the normal, two things could be accomplished. In the first place, the use of a high rate of pumping could be availed of to promote higher velocities, if it were necessary to resort to that arrangement, for eliminating the stranding of solids above the pumping

station. In the second place, the velocities of flow of harbor water at the dispersion area at the vicinity of the hour when the tide turns is less than it is on an average. When the velocity is abnormally low, for half an hour each way of the turn of the tide, it would be feasible to lessen the delivery of sewage, say cut it down to fifty per cent. or even less of the normal; that would tend to aid in lessening the volume of sewage meeting the less quantity of diluting water."

As part of the same general recommendation he says (Additional Test., p. 14):

"I have spoken already at some length of the desirability of removing stranded solids, and to do that, a number of things can be done, according to what is most convenient for the particular sewer in question. Flushing with water is efficient for dislodging these stranded solids, which putrefy and give off objectionable odoriferous products, and that is actually secured in those combined sewers when the storms come. It is feasible to apply a hose from hydrants from the water system and then discharge through the manholes to dislodge these solids. Another method which I have used in a number of cases with success is to install what I call a 'flushing gate.' By that I mean the placing in a manhole of a gate with a lever that can be operated conveniently by reaching down into the manhole. By closing this gate the flow of sewage is dammned up and there is accumulated a con siderable head, depending upon local conditions. Then upon pulling the lever and opening this valve quickly, there is established a scouring velocity which I found very helpful in quite a number of places in keeping the sewer quite free from stranded solids."

He makes as a final recommendation the following (Additional Test., p. 14):

"I might proceed also with the last point which I have considered in this program of betterment procedure, and that is to refer to the fact that, if

any extraordinary condition should arise during a very hot season, it would be possible to increase the removal of total suspended matters and of organic matter from the sewage passing through these basins by resorting to the use of chemicals. By that I mean to say, that lime and sulphate of alumina or sulphate of iron might be added to the sewage as it enters these basins. That the chemical treatment would promote the classification in conjunction with the sedimentation resulting from the flow of the sewage through the basins, and in my judgment would bring the removal of total suspended matters from about to sixty to eighty-five per cent. and of the total organic matter from about thirty to fifty per cent."

Asked as to whether he had any modifications to suggest as to the outfall and dispersion features of the proposed system, he says (Additional Test., p. 15):

"No. I have not, because I believe that these dispersion nozzles are the best that have ever been designed for any project. * * * I do not believe that there is any need at all of considering any betterments at the dispersion nozzles, because I do not believe there will be any likelihood whatever of a pool of sewage appearing at the surface."

To meet the evidence of Mr. Fuller, Complainant produced Professor Olin H. Landreth, who undertook to criticize in detail the recommendations for modifications of the proposed system of the Passaic Valley Sewerage Commissioners made by Mr. Fuller. It will be of interest to compare the qualifications of Mr. Fuller and Professor Landreth, who testified upon these matters. Thus, Mr. Fuller says (Additional Test., p. 3):

"I have been actively connected, I presume, with one hundred or more sewage disposal projects for American cities and towns during the past twenty years and more. These engagements covered about all of the ranges of sanitary engineering work; that is to say, that they have covered reports and investigations as to existing conditions,

> and the best means of solving the problems with recommendations as to the most advisable works, and the cost thereof, both for construction and operation. I have prepared plans and specifications for the construction of sewerage and sewage disposal works for quite a number of communities; also, I have supervised the construction and the operation of plants for sewage treatment."

Professor Landreth, on page 662 of the Additional Testimony, was asked:

> "What plants have you ever constructed for the purification of sewage"?

He answered:

> "I have not constructed any myself.
> Q. What have you operated?
> A. I have never operated myself."

Upon cross examination, this witness finally endorsed the views of Mr. Fuller in the following language (Additional Test., p. 623):

> "My only opinion as to what the Passaic Valley works will do is based on Mr. Fuller's very candid and distinct statement in his testimony in these present hearings, in which he says that the improvements will remove from 50 to 60 per cent. solids; but that improvements by retarding the velocities there is no room for doubt that it will remove 60 per cent., and that by the introduction of his plan for treating the sewage with precipitating chemicals, the removal will amount to 85 per cent."

He further says (Additional Test., p. 624):

> "I have made no study of the New Jersey situation on that point which is any more definite than Mr. Fuller's testimony."

As a reason for accepting Mr. Fuller's estimate he says:

> "Because it bears distinctly on the question that we are concerned with, namely, one of the standards to apply to the outfall of the Passaic Valley system, and because Mr. Fuller has given recent and doubtless careful attention to the matter, and has testified very definitely, and I have therefore accepted his statement."

Being asked (Additional Test., p. 633):

> "If an effluent of 150,000 gallons a day from the works thus described shall be discharged at or near Robbins Reef, in your judgment, will a local nuisance be created?"

He says:

> "A. I can only say that in my opinion that the effluent discharged from the works as you have described it, will not produce the results which are predicated in Section second.
>
> Q. Will there be a sleek field established there?
>
> A. I hardly think so.
>
> Q. Would there be a sewage field established there?
>
> A. I hardly think so."

This witness (Additional Test., p. 652) fixes upon 75 per cent. of removal of solid matter as sufficient for the full protection of the waters of New York Bay and testifies:

> "I think it is proper and I think it is attainable. If I may place any reliance on Mr. Fuller's testimony.
>
> Q. Attainable in what way?
>
> A. By screening and sedimentation. Mr. Fuller proposes to keep out 85%, even without any finer screens or even without any longer period of detention."

The conclusion of the testimony upon this branch of the inquiry appears to be beyond doubt that the treatment works under construction by the Passic Valley Sewerage Commissioners will produce an effluent which when discharged as stipulated into the waters of Upper New York Bay will produce the results guaranteed in the stipulation, that if this result in fact does not appear, changes in the structure of the sedimentation basins and the introduction of finer screens, the aeration of the effluent before it reaches the treatment works, and flushing of the stranded particles of organic matter, will cause an additional removal of solids and organic matter so that an effluent will be produced which, when discharged into the waters of Upper New York Bay, will have the guaranteed results without further treatment; that if this expectation is unfulfilled by the addition of chemical precipitants, a further removal of solids and organic matter can be accomplished which will result in an effluent of a character to meet the extreme requirements even of Professor Landreth and which will not under any conceivable conditions cause a local nuisance in the waters of the Upper Bay of New York. That there are other processes more elaborate and expensive was developed on cross examination of defendants' witness, Mr. Whipple (Additional Test., p. 232); such as subsurface irrigation, broad irrigation, intermittent filtration, contact beds and sprinkling filters; also for clarification,—settling basins, coarse filtration; for bacterial improvement,—land treatment, sand filtration, mechanical filtration and disinfection. It further appears from the testimony of complainant's witness, Kenneth Allen, that further processes known as the Activated Sludge Process and Myles Chemical Process are capable of being applied for the treatment of sewage in the proposed works at Red Hook.

III.

No diminution of the oxygent contents of the waters of New York Bay will be made by the discharge of the Passaic Valley sewage sufficient to affect the sanitary conditions of those waters.

The second ground upon which complainant asks an injunction is, that the discharge of the proposed effluent of the Passaic Valley sewage into the waters of New York Bay as proposed, will make such a call upon the dissolved oxygen in those waters as to set up nuisance conditions within the limits and along the shores of Greater New York. This result is feared because of the conditions existing there through the acts of the City of New York in discharging crude sewage at the surface of the water and in the most primitive and unsanitary manner possible. Naturally, existing nuisance conditions are entirely independent of the proposed Passaic Valley sewer, for the reason that the latter is not yet in operation and, as will be hereafter shown in this brief, if the City of New York abates its own nuisances, no possible nuisance can be caused by discharge of the effluent from the Passaic Valley sewage when the sewer shall be in operation. This will appear clearly from the evidence of complainant's own witnesses, first, as to the percentage of call upon the oxygen of the waters of the Upper New York Bay which will result from the discharge of the effluent in question, and, second, because of the conditions which will result in Upper New York Bay from the abating by the City of New York of the nuisances now in fact existing through its own acts.

Earle B. Phelps, upon whose testimony complainant placed great reliance, testified as to the proportionate part of the dissolved oxygen in the waters of New York Bay which would be consumed by sewage of a population of 700,000 human beings, being the then estimated popu-

lation of the Passaic Valley district. He says (Original Record, p. 1625), in answer to the question:

> "Q. So that your limits would be what of the polluting effect upon the waters of this particular area?
>
> A. About three and one-half to seven per cent. of the present pollution."

The area referred to by this witness will appear, by reading the context, to be the mouth of the Hudson River. The pollution testified to by this witness as existing in the area in question was represented by a reduction of 50 per cent. in the dissolved oxygen of the water within said area. Three and one-half per cent. of a pollution represented by a reduction in oxygen of 50 per cent. is itself represented by 1.75 per cent. of complete saturation and 7 per cent. pollution is represented by 3.5 per cent. of a complete saturation. In other words, the call upon oxygen of the waters of Upper New York Bay by the discharge of the effluent in question at Robbins Reef is estimated by Professor Phelps at 1¾ to 3½% of the full saturation content of the waters of the Upper Bay of New York. It is inconceivable, therefore, that this insignificant reduction in dissolved oxygen could have any possible effect in the establishment of nuisances along the shores of Greater New York or even in increasing the intensity of them.

IV.

There are many practicable plans of sewage disposal or treatment capable of being applied to the sewage of the City of New York and the several boroughs thereof in order to lessen the polluting character of said sewage upon the waters of New York Harbor.

The second subject of inquiry under the order of March 10, 1919, is as follows:

> "Any practical plan of sewage disposal or treatment capable of being applied to the sewage of the City of New York and the several Boroughs thereof in order to lessen the alleged polluting effect of said sewage upon the waters of New York Harbor."

The testimony taken on this subject is peculiarly illuminating and instructive and establishes beyond question that a sewage effluent produced as proposed by Passaic Valley Sewerage Commissioners from the sewage of a population of 800,000 inhabitants, when discharged as stipulated into the waters of Upper New York Bay at Robbins Reef, cannot, of itself, possibly create a general nuisance in the waters of New York Bay and will not be a sufficiently large contributing element of pollution to so result until the population sewering into the Upper Bay directly and indirectly shall have reached at least 15,200,000, and that the maximum population estimated for the Passaic Valley sewerage district of 1,600,000 cannot be a contributing element to a general nuisance until the population of Greater New York shall have reached 14,400,000 inhabitants.

Kenneth Allen, engineer for the Greater City of New York, who was charged with the duty of preparing plans for the relief of the sewage nuisances now existing along the shores of New York, testified that nuisances now exist in the slips of the piers, because of the discharge of sewage directly into the slips; in the Harlem River, be-

cause of the discharge into that confined body of water of large quantities of untreated sewage; in the Newtown Creek, Gowanus Canal, and Wallabout Bay, for the same reason, and in the lower reaches of the East River for the same reason. The plans which he testified to as under contemplation or approved of for disposing of the sewage of Greater New York and removing the nuisances now existing are as follows:

> "For the Manhattan Island Hudson River front, speaking generally, I believe that fine screens with a suitable submerged outlet will answer every purpose.
>
> (p. 489) For the Harlem River sewage diversion either to the Hudson River or the East River with screening or sedimentation. For the lower end of the East River, the intercepting of the sewage and carrying it to a point at or near Red Hook Island, there treatment by sedimentation and discharge into the deep waters by multiple outlets."

He further testified (p. 490):

> "No nuisance would be created in the waters of New York Bay by the discharge of 200,000,000 gallons of sewage directly into the Bay at Red Hook treated merely by sedimentation and screening."

Further, at page 494, he says in answer to the question:

> "Q. In your opinion, if the 200,000,000 gallons of sewage in question, being that which it is contemplated to discharge at Red Hook, or at an island off Coney Island, is removed from the waters of the Upper Bay, the discharge of the remaining sewage from the City of New York directly and indirectly into the waters of Upper New York Bay will be practically without injurious effect indefinitely, will it not?
>
> A. So far as I can see, yes, provided it is treated as planned.
>
> Q. That treatment as planned does not involve any more treatment than sedimentation and screening, does it?
>
> A. No."

This witness further says (Additional Test., p. 495):

> "Perhaps, I would make it a little clearer if I said that I did not think that the City of New York is going to grow a much larger size than 16,000,000 people.
>
> Q. Why do you say that the removal of 200,000,000 gallons of sewage from discharge into the waters of New York Bay will render New York safe and sanitary indefinitely, provided the rest of the sewage is treated by screening and sedimentation?
>
> A. I do not think the effect of that 200,000,000 gallons on the Bay is so important a matter in the plan of New York, as the relief of the Lower East River. That was the particular reason for carrying the sewage to an outlet island as planned by the Metropolitan Sewerage Commission."

That Mr. Allen is qualified as an expert in construction as well as design is shown by his qualifications and testimony. His conclusions with reference to the nuisance points, the method of abatement and the result of abatement, coincide with those of Messrs. Fuller, Whipple and Stearns testifying on behalf of the defendants. In fact it is quite refreshing to find expert witnesses on opposite sides agreeing as nearly as do these four experts. There is, therefore, no doubt left that in case the City of New York abates the now existing nuisances by constructing and putting into operation the various treatment plans designed by Mr. Allen and approved of and adopted by the appropriate authoritites, existing nuisances will be entirely eliminated, at a cost not exceeding forty-one million dollars and that the digestive capacity of the waters of Upper New York Bay and its tributaries will be sufficient to care for the sewage of a population of 16,000,000 inhabitants without any resultant local or general nuisance. The present population contributing sewage to Upper New York Bay is six million. If the waters of the Bay are capable of disposing the sewage of 16,000,000 inhabitants, or in other words, an additional 10,000,000,

provided the sewage is treated by screening and sedimentation, we ask, how is it that the addition of sewage of 800,000 inhabitants in 1940 will produce a nuisance? It will be noted that in fixing 16,000,000 inhabitants as the limit which can be accommodated by the sewage digestive capacity of Upper New York Bay, witness Kenneth Allen substantially agrees with the testimony of George J. Johnson, George W. Fuller, Frederic P. Stearns and George C. Whipple, and other witnesses for the defendants.

V.

The additional testimony establishes the existing pollution of the waters of New York Harbor resulting from the unscientific and unsanitary method of sewage disposal of the City of New York and increased pollution from that source since the time when the original testimony was taken in this case.

The third subject of inquiry specified in the order of March 10, 1919, is as follows:

> "Additional testimony (to the extent reasonably practical within the time herein limited) as to the present degree of pollution of the waters of New York Harbor, including those parts affected or to be affected by the proposed Passaic Valley Sewerage system and by the sewage of the City of New York; and the change, if any, in the degree of such pollution since the time to which the testimony heretofore taken relates."

On this subject defendants introduced the testimony of Mr. George C. Whipple, an expert of large experience and practical knowledge and who had made determinations of the oxygen content of the waters of New York Bay in 1909. Those determinations were made in the month of November and under the order above referred to it was impossible to make determinations in the same

month in the year 1919. The results of Mr. Whipple's determinations are given in his testimony beginning at page 155 of the additional testimony and in the three exhibits numbered respectively 8, 9 and 8a, found at pages 169, 173 and 249 of the Additional Testimony. No question is raised as to the competency, honesty or ability of Mr. Whipple. The result obtained by him appears somewhat surprising because of the fact that in many instances the oxygen content of the water of 1919 appears to have been better than in 1909. Mr. Whipple, however, practically admitted that these differences are frequently to be accounted for by seasonal differences in the months of May and November and that it was entirely to be expected that depletion of the oxygen content of the waters would be shown to have increased since the taking of the last testimony in this case by reason of the increase in population sewering directly or indirectly into the Upper New York Bay.

The result of the testimony of Earle B. Phelps, a witness produced on behalf of the complainant, indicates a considerable falling off in the oxygen content of the waters, but it will be observed that these determinations were got at the most unfavorable season of the year, and are admitted by Mr. Phelps to be excessive and not a fair guide to the real average determination of the oxygen content of the waters. How much real importance any specified percentages of oxygen content of the waters may have can be estimated by the testimony of the defendants' witnesses Fuller and Whipple (Additional Test., pp. 16, 17, 211), and so long as any oxygen remains there is no danger of the creation of a nuisance of any kind, local or general, and from the fact that New York plans to discharge the sewage of 16,000,000 inhabitants into the waters of Upper New York Bay without regard to the question of whether or not the oxygen content of the water shall have fallen considerably below that shown by most recent determinations.

That the effect of the oxygen depletion is greatly ex-

aggerated by all the experts is shown by the extraordinary health conditions of the City of New York. Pollution of waters adjacent to a city is feared by reason of its consequence in producing typhoid germs. A vast amount of evidence was introduced on the part of the plaintiff in the Chicago Drainage Canal Case to demonstrate that the consequences of discharging the sewage effluent of the Chicago Drainage District through the canal into the Mississippi River above St. Louis would be epidemics of typhoid fever in that city.

Missouri v. *Illinois*, 200 U. S., 496.

The Court did not yield to the contention, and subsequent events have demonstrated that the fears were unfounded and "the scientific guesses" unreliable.

So while experts in the case at bar for years past have been talking about the exhausted oxygen content of the waters of New York harbor, the health of the city has been increasingly good.

The last published Annual Report of the Department of Health (for the year 1918) contains the following statement (p. 53):

> "*Typhoid Fever.* It has been virtually a tradition that the typhoid fever rate remains a reliable index of the attitude of communities toward sanitation and public health. If it were possible to bring home to the citizens of New York City in a clear and intelligible way a realization of how much safer it is to live here as compared with many other cities and as compared with conditions twenty years ago in this City, they might more readily appreciate how their sympathy and support of public health work counts, that public health is purchaseable, and that within certain reasonable limitations, a community can determine just how safe life can be made for all persons in that community. During 1898, when the consolidation of the greater city occurred, the death rate from typhoid fever was 21 per 100,000 persons. The population was 3,250,000, and the deaths re-

ported were 676; the deaths from typhoid during ensuing ten years hovered between 676 and 740. Even in 1902, 21 out of every 100,000 persons in New York City died from typhoid fever. During 1918 we had only 196 deaths from typhoid, or three per 100,000 persons, as contrasted with the 21 in 1898. Over 2,200 cases of typhoid were reported in 1898 and the number of cases reported during intervening years varied in proportion to increase in population, until 1907, when 4,426 cases were reported. Since 1907 we have had a very signal reduction in incidence of typhoid fever in this city, so that in 1918 we had a total of 1,238 cases, although population had increased to nearly six million.

"If the same mortality rate which prevailed in 1898 had continued to date, instead of 196 deaths from typhoid, we would have had 1,246 deaths last year. These achievements are not the result of accident or good fortune, but direct consequences of the application of intelligent and expert effort in sanitary science. * * * Year by year a very steady and distinct reduction in cases and deaths from typhoid has thus been accomplished. During 1917, for instance, 1,442 cases were reported as against 1,238 in 1918. During 1917, there were 229 deaths from typhoid as against 196 during 1918."

VI.

Reply to Complainant's Supplemental Brief.

In the preliminary statement comprising seventeen pages of complainant's supplemental brief and purporting to be a re-statement of law and fact under the original testimony in this case, there appear a number of misconceptions which, if uncorrected, possibly might be prejudicial to defendants. Thus the citation from the testimony of the "eminent scientist," Professor William T. Sedgwick, has been given the semblance of conclusiveness, as if there were no evidence to contradict it. The fact, however, is that complainant's own witness, Harrison P. Eddy, perhaps not "an eminent scientist" but cer-

tainly a practical sanitary engineer, who has had personal knowledge of the conditions in and about the Passaic River, Newark Bay, the Kill van Kull and Upper New York Bay, testifying on the same subject matter (Original testimony, p. 1496), said:

> "The fact that the sewage of the Passaic Valley is discharged into the Passaic River, the oxygen is depleted, and the water with the oxygen passes through the Bay and comes out into New York Bay. All those facts show that the water from Newark Bay does have an effect upon the pollution of New York Harbor. It tends to increase it."

Being asked,

> "Q. And the organic matter that is discharged into New York Bay from Newark Bay, is it in the state of decomposition in your judgment?
> A. Undoubtedly.
> Q. Has it been some time on the way?
> A. Yes, sir.
> Q. And being subject to septic influences of one sort and another?
> A. At a good many times, at seasons of the year, that is undoubtedly true."

On page 1497, original testimony, in answer to the question,

> "Q. But the organic matter that finds its way into New York Bay from Newark Bay, in your opinion, is it in a state of decomposition?
> A. It is."

Mr. Eddy further testified, on same page:

> "The waters which enter New York Bay from Newark Bay are in a condition which is quite similar to that of the water of New York Bay. Instead of having the advantage of the clean water which was originally provided by nature, it is very much depleted in oxygen, and carries more or less organic matter. I do not know, it would be impossible to say, to what extent that is effective in reducing the oxygen in New York Bay. Undoubtedly it plays an important part."

From the evidence of this witness two things appear, (1) That the allegation in defendants' answer criticized by Professor Sedgwick is justified by the facts, and cannot be lightly disposed of in the off-hand manner adopted by Professor Sedgwick. (2) That the sewage of the Passaic Valley is not foreign or alien to Upper New York Bay. That it is produced within the water shed of Upper New York Bay and is transported to it in the same sense as the sewage of the cities and towns on the Hudson River from Troy down to and including the City of New York. In this respect the sewage of the Passaic Valley differs from that of the Bronx Valley and the Harlem River, which both normally discharge either into the East River or into Long Island Sound, which have either been or are designed to be diverted in whole or in part into the waters of the Hudson River.

We hesitate to refer to the testimony of Rudolph Hering in this cause, for the reason that he was produced as a witness by complainant and testified on its behalf, notwithstanding the fact that he signed the certificate with George W. Fuller and Edlow W. Harrison. Defendants' Exhibit No. 5, which was the basis and foundation relied upon by the Passaic Valley Sewerage Commissioners in entering into the stipulation with the United States, Complainant's Exhibit No. 135. But inasmuch as counsel for complainant have again cited it in their supplemental brief as authority for the statement that there was a better method of treatment for the sewage of the Passaic Valley than that proposed by defendants and approved by the witness we quote what he actually said (Original Testimony, p. 2866):

> "I have only investigated the question so far as a few towns are concerned. I am not prepared to say whether it will be applicable to any of the other towns because I have not investigated it."

Further on in his testimony, it appears that the towns in question are Montclair, Orange and East Orange, and

the further fact appears in the testimony that East Orange has come into the Passaic Valley trunk sewer, and has definitely rejected the Imhoff tank system process recommended by Mr. Hering, probably because of the necessity of adding to that treatment processes of oxidization by land or sprinkling filters, with all the objectionable features incident to those processes. It is also true that there is no large city in this country which has adopted the system of treatment for its sewage apparently recommended by Mr. Hering.

On page 9 of the supplemental brief, there is repeated the charge, appearing in various forms throughout the case, that the New Jersey communities are seeking to transfer to New York the nuisances of a polluted stream by creating in *"its harbor"* a nuisance of an intolerable character. Attention is called to the appropriation by complainant of the whole of the Upper New York Bay as indicated by the designation of it in the brief as *"its harbor."* This expression appears to indicate the mental attitude of complainant's counsel that Upper New York Bay is the property of the State of New York and that New Jersey exercises privileges in it only by sufferance of New York. So far as the charge that New Jersey seeks to transfer a nuisance of an intolerable character into Upper New York Bay, we have already made extended reference to the evidence in the case indicating just what will result from the operation of the Passaic Valley sewer. There should be added, however, this statement. The liquid wastes of the Passaic Valley instead of being discharged into the Passaic River, there to become an intolerable nuisance and to be borne thence into the Kill van Kull and into Upper New York Bay, will be intercepted, clarified and discharged into the deep waters of New York Bay where there will be insured dilution by harbor water sufficient in volume to destroy all the characteristics of sewage remaining after the treatment and to transform it into harbor water. In this connection, Frederic P. Stearns, sanitary engineering expert and practical

operator of sewage plants, called on behalf of the defendants (Additional Test., p. 120), speaking of the results obtained from the submerging of the Deer Island outlet of the Metropolitan sewers and making the discharge into the deep waters through fourteen separate outlets, says:

> "By the time a mixture of that kind (each part of sewage is mixed with twenty times its volume of harbor water) is reached, it practically is not sewage."

Coming now to the consequences alleged in complainant's brief as sure to occur from the discharge of the Passaic Valley trunk sewer into Upper New York Bay at Robbins Reef, we find them specified as follows: Public nuisance injurious to public health and the comfort of the citizens of the State of New York; public nuisance injurious to commerce by the formation of enormous sewage fields giving off offensive and unwholesome emanations injurious to both health and property; public nuisance injurious to the hulls of vessels and wharves, docks and other structures, property of the citizens of New York; public nuisance from poisonous gases emanating from the sewage field, exposing citizens and travellers to the dangers of disease as well as annoyance and discomfort through the excessive pollution of *our harbor* waters, the driving away or poisoning of fish used for food that swim in the waters, or the oysters, clams and other fish that now exist in large areas throughout our harbor.

The Stipulation Is Valid and Enforceable.

Taking these consequences in the order stated it appears beyond possible question:

1. That no sewage field will be in fact formed. In making this statement we rely entirely upon the evidence of complainant's witnesses Kenneth Allen and Professor Landreth, who both stated with positiveness that the discharge of 200,000,000 gallons of sewage per day taken

from the Brooklyn sewers and treated by screening and sedimentation and discharged at or near an artificial island off Robbins Reef at the edge of the ship channel will not produce a nuisance and will not create a sewage field nor a sleek field, and the further testimony of Professor Landreth that the discharge of 150,000,000 gallons per day of the effluent of the Passaic Valley sewer at Robbins Reef will not produce a sewage field nor a sleek field. The necessary consequence seems to be that there will not be a sewage field created and no offensive or unwholesome emanation will arise from the proposed discharge of the Passaic Valley sewer which will be injurious to health and property.

2. Careful examination of the testimony, both original and additional, fails to disclose an opinion of any expert witness for complainant or defendants that the odors from sewage, even as concentrated and noxious as it is in the Passaic River, can be identified as the cause of any specific disease. That the consequence of the statement that the anticipated sewage field, if in fact it were created, would be injurious to health is without foundation.

3. The alleged fear of injuries to the hulls of vessels, wharves, docks and other structures, property of the State of New York, seems to be far fetched in view of the fact that by the acts of the City of New York and its own neglect of even the most primitive sanitary precautions in the discharge of its sewage, nuisances have been created in the slips along the piers in which vessels remain for hours, days and weeks. Nuisances have been set up in the Gowanus Canal, Wallabout Bay and Newtown Creek used in the commerce of the City of New York and as to Gowanus Canal in particular counsel for complainant has again and again insisted that the tonnage and value of the commerce using this waterway exceed in value and amount that of the Mississippi River. In view also of the fact that the Harlem River under the

evidence of complainant's own witnesses has been rendered a nuisance and that the lower East River is rapidly reaching the same condition.

4. The allegation that the discharge of the sewage in question will either drive away or poison fish used for food that swim in the waters of New York Bay or will poison the oysters, clams and other fish that now exist in large areas throughout *our harbor* waters, seems hardly serious on the part of the complainant in view of the fact that the sewage discharge of the Greater City of New York amounts to 900,000,000 gallons per day, that it is poured without treatment into the harbor waters and into the Upper Bay, that this discharge is at least ten times in amount of that planned to be discharged from the Passaic Valley sewer. Surely food fishes must either have been driven away or poisoned and the oysters, clams and other shell fish which are asserted to exist in the harbor waters in large fields have been rendered unfit for human food. The fact is that no fresh fish are actually taken from the waters of Upper New York Bay and that no one knowingly is so foolhardy as to eat fish which have been propagated in those waters or within reach of the sewage borne by those waters. If it were possible to do anything additional to destroy or impair the alleged value of fisheries supposed to exist in Upper New York Bay, that will be found to be planned by New York City under its purpose for continuing the discharge of its sewage into the waters of Upper New York Bay until its population shall have reached the figure of 16,000,000 human beings.

In dealing with the additional testimony, complainant's supplemental brief does not so much attack the evidence actually presented on behalf of defendants as it assails the binding effect of the stipulation (Complainant's Exhibit 135).

In their original brief complainant contended that the stipulation was not made under the authority of any act

of Congress, but rested entirely upon the implied authority of the Attorney General in connection with the appearance of the United States as an intervenor in a suit between the states; that while the performance of the stipulation was subsequently made a condition of the granting of the permit by the War Department for the construction of the outlet and shaft house in the bay, the Secretary of War, in granting this permit, was acting under the authority of Section 10 of the Act of March 3, 1899 (30 Stat., 1151), which relates simply to physical construction; that the authority of the Secretary of War only extended to the consideration of the proposed erection as a possible physical obstruction to navigation. (See complainant's brief on final hearing, original argument, pp. 75-80.)

The same argument is renewed in complainant's supplemental brief on pp. 21-24.

While it is true that the agreement as to the physical structure and actual performance of defendant's proposed plant was first embodied in the stipulation with the Attorney General of the United States, made April 14, 1910, the provisions of that stipulation on the part of the defendants were afterwards made conditions to the permission of the Secretary of War to construct and maintain the structures under the navigable waters of the Bay of New York. The Passaic Valley Sewerage Commissioners were expressly authorized to enter into this stipulation and contract with the United States by special act of the Legislature of New Jersey, approved April 8, 1910 (ch. 158). That act empowered the Commissioners, for themselves and their successors,

> "to enter into a stipulation and contract with the United States concerning the manner in which any sewer made or managed by said Passaic Valley Sewerage Commissioners and discharging into the New York Bay shall be constructed, maintained and operated, and concerning the character and effects of the sewage discharged by said sewer into New York Bay, and concerning the terms or condi-

> tions in reference to the construction, maintenance, operation or effects of such sewer which said Passaic Valley Sewerage Commissioners consent to have introduced into such permits as may be requisite under the statutes of the United States for the construction, maintenance or operation of said sewer. * * *"

The Acts of August 18, 1894, Sec. 4 (28 Stat., 362), June 13, 1902, Sec. 11 (32 Stat., 374), August 8, 1917, Sec. 7 (40 Stat., 266), which are consolidated in Barnes' Federal Code of 1919 as Section 9393, provide as follows:

> "It shall be the duty of the Secretary of War to prescribe such regulations for the use, administration and navigation of the navigable waters of the United States as in his judgment the public necessity may require for the protection of life and property, or of operations of the United States in channel improvement, covering all matters not specifically delegated by law to some other executive department."

By the Act of March 3, 1905, Sec. 4 (33 Stat., 1117, 1147), Barnes, Sec. 9397, dumping into the navigable waters of the United States of dredgings or refuse materials of every kind and description, is prohibited except as the same may be authorized by the Secretary of War, who is authorized to make such regulations concerning the same as in his judgment are required in the interest of navigation.

Section 13 of the Act of March 3, 1899 (30 Stat., 1151), provides

> "that it shall not be lawful to throw, discharge or deposit * * * any refuse matter of any kind or description, other than that passing from streets or sewers and passing therefrom in a liquid state, into any of the navigable waters of the United States * * * whereby navigation might be impeded or obstructed * * * and provided further that the Secretary of War, whenever in the judgment of the Chief of Engineers anchorage and navigation will not be injured thereby, may permit the deposit of

any material above mentioned in navigable waters * * * and whenever any permit is so granted the conditions thereof shall be strictly complied with, and any violation thereof shall be unlawful."

Section 10 of the Act of March 3, 1899, provides:

"The creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is hereby prohibited; and it shall not be lawful to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty or other structures in any port, roadstead, haven, harbor, canal, navigable river or other water of the United States, outside established harbor lines, or where no harbor lines have been established, except on plans recommended by the Chief of Engineers and authorized by the Secretary of War; and it shall not be lawful to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of any port, roadstead, haven, harbor, canal, lake, harbor of refuge, or inclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of War prior to beginning the same" (Barnes, Sec. 9376).

Under these statutes, no such structures, as the plans of the Passaic Valley Sewerage Commissioners provide for, can be constructed under the waters of the harbor except with the permission of the Secretary of War acting through the Chief of Engineers, and a permit granted by him may be made upon such terms and conditions as he shall prescribe. The fact that some of these conditions have reference to the character of the effluent which may be discharged into the navigable waters through the pipes to be laid on the floor of the Bay, does not make the imposition of the conditions void as an unlawful extension of the powers of the Secretary. Thus, under the Constitution of New York, the Legislature can only grant a

franchise to construct and operate a street railway on condition that the local authorities having control of the streets and highways upon which it is proposed to construct a road, shall consent to such construction. In the exercise of such power it has been held that the local authorities may impose such conditions as in their judgment the interests of the municipality may require, however onerous and difficult to perform such conditions may seem.

> *People ex rel. South Shore Traction Co.* v. *Willcox*, 133 App. Div., 556, 563;
> *Public Service Commission* v. *Westchester Street R. R.*, 206 N. Y., 209;
> *People ex rel. Westchester Street R. R.* v. *Barnard*, 110 N. Y., 548, 553.

The same principle has been established in Pennsylvania. See *Allegheny* v. *Street Railway Co.*, 159 Pa., 411. The Constitution of that state provides that

> "no street passenger railway shall be constructed within the limits of any city, borough or township without the consent of its local authorities."

Held, that in granting to a street railway company a privilege of using streets, a municipality may impose conditions under which the right may be enjoyed by the company, and may, for example, require, as a condition to this consent, that a certain designated rate of fare shall be charged, and a certain per cent. of the dividends paid to the municipality. The Court said (p. 416):

> "It would require a very clear case of the contravention of some controlling and paramount principle of public policy to justify an interference by the courts to put a limit on the unlimited constitutional grant."

In *U. S.* v. *Romard*, 39 Fed., 156, it was held that an act of Congress prohibiting the deposit of refuse and other material within the harbor of New York was con-

stitutional; that such deposit might, in legal contemplation, constitute "an obstruction to navigation." The Court said (p. 159):

> "While waterways are intended to be used for the purpose of navigation, and while a qualified right to use the same for such purpose may exist, yet there is no primary right, qualified or otherwise, to deposit obstructive material in public water, and it is quite within the jurisdiction of congress to authorize public officers to prevent such deposit, in whole or in part, or, if such deposit be suffered, to direct the supervisor of the harbor to fix the time and places and places when and where injurious deposits shall be made, and to command obedience to the directions of such officer."

The statute prohibiting dumping in New York Harbor was upheld in *Randall et al.* v. *U. S.*, 107 Fed., 935 (C. C. A., 2nd Cir.).

The argument that the stipulation does not constitute an agreement with the State of New Jersey and does not purport to bind the State of New Jersey is conclusively disposed of by the provisions of the act of the Legislature of that State, authorizing and empowering the Passaic Valley Sewerage Commissioners, for themselves and their successors, to enter into the stipulation and contract, and to have the terms and conditions introduced into such permits as may be requisite under the statutes of the United States for the construction and maintenance or operation of the sewer.

Complainant's contention that Section 10 of the Act of 1899 relates simply to physical obstacles is not supported by the language of the statute itself. The prohibition is two-fold: (1) of the creation of any obstruction, not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States; and, (2) of the building of any of the designated physical objects. That the putting into the water of light, flocculent matter carried in suspension by moving streams of

the water may constitute an obstruction to navigation, has been expressly affirmed in *U. S.* v. *North Bloomfield Gravel Mining Co.*, 81 Fed., 243. In that case, it appeared that Congress had established a commission to ascertain and determine whether the various hydraulic mines within the territory drained by the Sacramento and San Joaquin River systems can be operated by means of impounding reservoirs and other works without injury to those navigable waters; and if so, permitted them to be operated in such a way as to prevent such injury. The act appointed a commission to investigate and control this subject, and in fact declared that light, flocculent matters resulting from hydraulic mining processes did constitute an obstruction to navigation when the Federal Debris Commission, acting under orders of the Secretary of War, so determined. This was held to be a constitutional exercise of the power to regulate interstate commerce.

In the Circuit Court, Ross, *J.*, said (pp. 253-254):

> "It is too late now for any one to question the power on the part of Congress to declare that debris of any character, or other thing, constitutes an obstruction to the navigable waters within its control, and to prohibit the use of such waters by any such debris or other thing. The power to absolutely prevent the use of such waters for the objectionable purposes necessarily includes the power to prescribe the terms and conditions upon which they may be so used."

The stipulation, which is a condition to the permit granted by the Secretary of War to construct and maintain the proposed structure of the Passaic Valley system under the waters of New York Bay, specifically provides that the operation of the system shall at all times secure the results specified

> "either through compliance with the requirements of the immediately preceding paragraphs or through requisite lawful additional arrangements."

Even the complainant's experts, who differed with those of defendants respecting the performance of the plant as proposed to be constructed, admitted that the result stipulated *could be secured.* Thus, Theodore Horton, denominated in complainant's supplemental brief as "an eminent expert," testified:

> "My opinion is that if the sewage of these boroughs in the City of New York were treated in such a way as to produce an effluent such as would meet the stipulations guaranteed, I think the sewage would be sufficiently treated to prevent largely a nuisance and would be substantially free from a a menace to health."

He added that in his opinion an effluent can be produced from the sewage of the Passaic Valley which, when discharged in New York Harbor, would produce the results as they are stated in the stipulation (Original Record, p. 2306). Again he said:

> "Assuming that the intent of the Passaic Valley Sewerage Commissioners and the Secretary of War or the Government in this case is to carry out the guaranteed results, I think there would be very little nuisance and very little menace to health" (Original Record, p. 2307).

To same effect, Dr. Robert S. Weston (pp. 1986-1989), and James J. Powers (p. 2647).

Dr. Daniel G. Jackson testified that in his testimony he had assumed that the effluent coming from the Passaic sewer would be treated only by screening and sedimentation; that there were other processes by which an effluent would be produced which would comply with the stipulation as to the guaranteed results (Original Record, p. 2180). To the same effect, Harrison P. Eddy (p. 1504), John P. Fox (p. 1223).

John W. Alvord (Original Record, p. 1900), said that it couldn't be produced by the means described, but James H. Fuertes, called by complainant (Supplemental Brief,

p. 8), "an engineer of wide experience," said: "It can be done." And Dr. Walter Bensel: "I know it can be" (Original Record, p. 2288).

Charles E. A. Winslow testified that "the only kind of a plant that could produce the results in accord with the literal meaning of these stipulations as to results, would be intermittent sand filters, and they would be very expensive" (Original Record, p. 1669).

On the other hand, James J. Powers, testified: "It could be done in a number of different ways" (Original Record, p. 2647).

Indeed, most of complainant's witnesses on cross examination conceded that the guaranteed result might be produced by suitable arrangements, although as is the way with experts, each one of them had his own pet system and was unwilling to concede excellence in that of others. Some of the complainant's witnesses, as, for example, Desmond Fitzgerald, in their testimony assumed that the stipulation allowed the discharge of sewer off Robbins Reef "without any other purification than that incident to subsidance for an hour" (Original Record, p. 1595).

Thus it is demonstrated that the conditions prescribed in the permit of the Secretary of War, under which is to be constructed and maintained the pipes and structures under the waters of the harbor, are binding and enforceable. They are capable of performance, and if their requirements are not met by the system proposed to be put in operation, changes such as those suggested by Mr. Geo. W. Fuller, or some other feasible alterations, can be made which will meet the requirements. Defendants' experts, in view of practical experience with many other plants, believe that these results will be attained without altering the plant as proposed to be constructed. If their opinions should prove unsound, then defendants would have to make changes which would meet the requirements of the Secretary of War.

The complainant's brief seeks to impute to defendants

a doubt as to the sufficiency of their existing plans. On page 23, they say:

> "It is to be noted that the arrangements are 'additional' thus emphasizing the doubt of the parties themselves with respect to their present plan."

We submit that this is not the proper inference to be drawn from the language in question. The provision is intended to cover a contingency which is recognized as *possible*, however improbable.

VII.

The first subject of inquiry under the order of March 10, 1919, is understood to elicit the specification in detail of such modifications of the system of sewage disposal, (1) in construction, (2) in arrangement, and (3) in operation, which will insure the performance of the terms of the stipulation in the event that experience should demonstrate that the plant shall not meet the expectations of its designers. To this end defendants introduced the testimony of George W. Fuller, whose qualifications and experience are set out in his preliminary examination. This witness specified certain modifications of construction, arrangement and operation which could be made part of the system, in the event that the guaranteed results were not produced by the works as specified in the first section of the stipulation. These recommendations group themselves as follows:

1. Changes in construction and arrangement as follows: modification of the sedimentation basins by which a greater removal of solids will be insured, the installation of fine screens in the effluent waterways. the aeration of the sewage in an interceptor above the pumping station.

2. Modification in operation consisting of variations in the rate of pumping the sewage into the Bay so as to

cause a reduction in the discharge at the time of slack tides in the Bay, the prevention of the stranding of putrefying solids in the flat grade sewers tributary to the trunk sewer, and the use of chemical precipitants as a last resort.

Each of these recommendations is substantial and not illusive and trivial. In criticising Mr. Fuller's first recommendation complainant's supplemental brief questions his opinion that the plant as now being constructed would remove between sixty and fifty per cent. of the total suspended matter in the sewage and between twenty-five and thirty per cent. of the total organic matter, and quotes the testimony of several of the experts for complainant appearing in the original record which placed the probable removal of solids in the basins as designed, at amounts ranging from that of Mr. Eddy of 30 per cent. down to that of Theodore Horton of from five to ten per cent. The difficulty with these opinions is manifestly that they vary too greatly to have any scientific foundation or value. In contrast with them, however, we refer the Court to the testimony of Nicholas S. Hill, Jr., one of complainant's own witnesses, who says (Original Test., p. 2162):

> "With reference to the first method of treatment called for under the stipulations between the United States and the Passaic Valley Sewerage Commissioners, comprises screening and settling in tanks which have a capacity which shall provide for detention of an hour and a half, based on the daily average flow of sewage. In general figures this will probably mean a reduction of 50 per cent. in the suspended matter in the sewage. As a general average it may be assumed that the suspended matter carried with it about 50 per cent. of the total organic matter."

This opinion coincides with that of Mr. Fuller and is in sharp contradiction of the evidence of complainant's witnesses cited in complainant's supplemental brief.

In so far as this brief deals with Professor Landreth's criticisms of the recommendations of Mr. Fuller, we again urge upon the Court's attention, first, the relative qualifications of Mr. Fuller and Professor Landreth by training and experience and to the final endorsement by Professor Landreth of the conclusions reached by Mr. Fuller as having been based upon more complete and recent study of the problems and a greater knowledge of the conditions under which the treatment works will operate.

With respect to the testimony taken under the second paragraph of the order of March 10, 1919, complainant's brief is singularly incomplete and inconclusive. Starting out with the statement that there is no dispute as to the practical means of the disposal of the sewage of New York City, it goes on with citations from testimony of witnesses with relation to the complexity of the problem for the City of New York, then admits that existing conditions in New York City demand immediate action for the removal of nuisances, discusses the plans of the Metropolitan Sewerage Commission and the Sewerage Plan Commission, gives an estimate of the cost of construction of the necessary works, first assuming a disposal plant at Red Hook, and, secondly, a disposal plant at an ocean island, states the relative cost of sewerage works under the two plants at $32,100,000 and $41,403,000, and closes with the statement

> "that the testimony thus establishes that New York City, confronted as it is with the most difficult problem, has for many years carried on an investigation as to the best possible method of meeting the situation and that it has prepared plans in accordance with the best advices which it could receive and that the sanitary engineer called to testify by the defendants was unable to add any suggestion to the plans which had already been considered and passed upon by the State of New York."

How lame and impotent is this conclusion, will appear from the fact that notwithstanding the admission of the existence of local nuisances due to its own acts, despite all

the investigations and plans for the removal and abatement of these nuisances, and the ascertainment of the cost of carrying them out, no work actually has been done, with the exception of the construction of one small screening plant at Dykeman Street at a cost of about $77,000. Even this plant, appears to have been used chiefly for the demonstration of the merits of a patented screen rather than for the treatment and disposal of sewage. The fact is that the testimony produced by defendants and by the complainant itself on this branch of the inquiry is embarrassing to the complainant, inasmuch as it clearly appears that in the opinion of its own expert engineers by processes of screening or sedimentation, or both, by the intereception of certain parts of the sewage and the transportation of it to the disposal plants and the application of screening and sedimentation and the discharge of the effluent into deep waters by multiple outlets not only can the City of New York abate the nuisances existing at present, but in fact would prevent further or other local nuisances at the points of discharge and abate the general nuisance throughout the waters of the Upper Bay of New York, existing by reason of its own acts. Not only that, but it would thus insure a safe and satisfactory disposal of the sewage of New York, not only for the present, but up to the year 1960, at which date it is estimated that the maximum population possible in the district will have been reached, viz: 16,000,000 inhabitants.

Taking the evidence as it stands on this subject of inquiry, it seems to be demonstrated that the discharge of sewage effluent of a population of 800,000 now in the Passaic Valley district cannot possibly create a nuisance, either local or general, in the waters of Upper New York Bay if it be true that an increase of population of the City of New York of 10,000,000 inhabitants will not cause such nuisances and that a population of 1,600,000 inhabitants estimated for the year 1940 in the Passaic Valley sewerage district will not then create a nuisance, local or general, nor will such nuisances arise until the population

of the City of New York shall be at least 14,400,000 inhabitants.

In view of the testimony introduced upon the second subject of inquiry, the conclusions of complainant's supplemental brief as to the result of the testimony on the third subject of inquiry seem to be of small importance, it being admitted that the dissolved oxygen is constantly being absorbed but it being made apparent that it is not likely to be reduced below the danger point before 1960 or before the population discharging sewage into the waters of the Upper New York Bay shall be at least 16,000,000. From the testimony taken in the whole case, including the additional testimony, we submit,

(1) That the sewage works as they are being constructed will produce the guaranteed results contained in the stipulation with the United States.

(2) That in the event of this conclusion being mistaken defendants have suggested practical modifications in construction, arrangement and operation of the system of sewage disposal which will lessen the alleged polluting effect of the effluent and will insure compliance with the stipulation above referred to.

(3) That the nuisances complained of by complainant as existing within its own territory can be abated by the putting into operation of the plans already adopted, and that the waters of the Upper Bay will then be a safe and sanitary disposal of the sewage of a population of at least 16,000,000 inhabitants, and that, therefore, the contribution of the Passaic Valley sewerage district of the effluent of sewage from 800,000 to 1,600,000 is not a factor of any importance and is no more than the State of New Jersey is entitled to by reason of its territory being riparian to the waters of Upper New York Bay.

(4) That the pollution of the harbor waters which now exists is due almost entirely to the City and State of New York, that it is increasing in amount but that

upon the adoption of feasible and comparatively inexpensive plans for sewage treatment the sewage digestive capacity of the Bay will be practically inexhaustive.

Defendants therefore respectfully urge that the complainants' Bill be dismissed.

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Attorney General of the State of New Jersey.

ADRIAN RIKER,
Counsel, Passaic Valley Sewerage Commissioners.

GEORGE W. WICKERSHAM,
ROBERT H. McCARTER,
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Supreme Court, U. S.
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No. 2 Original

IN THE

Supreme Court of the United States.

October Term, 1920

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,

vs.

THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

SUPPLEMENTAL BRIEF AND ARGUMENT FOR COMPLAINANTS ON THE COMING IN OF ADDITIONAL TESTIMONY.

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THE STATE OF NEW JERSEY and PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

SUPPLEMENTAL BRIEF AND ARGUMENT FOR COMPLAINANTS ON THE COMING IN OF ADDITIONAL TESTIMONY.

This is an original bill to restrain the construction and operation of a trunk line sewer to be built for the purpose of conducting the sewage of the Passaic Valley Sewerage District of New Jersey to a point in New York Bay near Robbins Reef Light (that is, in the upper New York Bay off Staten Island) and there discharging the same to

the serious injury of the people of the State of New York.

The cause came on to be heard before this Court and was argued on November 8th, 11th, 12th, 1918. This Court deemed it proper that additional and supplemental proofs be taken for certain purposes and on March 10, 1919, entered an order opening the case for additional and supplemental proofs and appointing James D. Maher, Esq., Commissioner for the taking of testimony (*New York* v. *New Jersey*, 249 U. S. 202). The order is as follows:

> "This cause came on to be heard at this Term and was argued by counsel; and it appearing that the suit was begun by bill filed October 17, 1908, that answer was filed January 4, 1909, and that the cause was put at issue by replication filed November 8, 1909; that the taking of testimony was begun on June 26, 1911, and closed on June 27, 1913, more than five years before the final argument of the cause in this court; and the court deeming it proper that additional and supplemental proofs should be taken for the following purposes:
>
> "It is ordered that the defendants may proceed with all convenient dispatch to take the testimony of not exceeding three sanitary or engineering experts, deemed by them best qualified, concerning the following subject-matters:
>
> "(1) Any practicable modification of the proposed system of sewage disposal of the Passaic Valley Sewerage Commissioners, either as to construction, arrangement, or operation, and the nature and character of sanitary or engineering appliances that may be added thereto or introduced therein, in order to lessen the alleged polluting effect of the effluent upon the waters of New York Harbor.

"(2) Any practicable plan of sewage disposal or treatment capable of being applied to the sewage of the City of New York and the several Boroughs thereof in order to lessen the alleged polluting effect of said sewage upon the waters of New York Harbor.

"(3) Additional testimony (to the extent reasonably practicable within the time herein limited) as to the present degree of pollution of the waters of New York Harbor, including those parts affected or to be affected by the proposed Passaic Valley Sewerage system and by the sewage of the City of New York; and the change, if any, in the degree of such pollution since the time to which the testimony heretofore taken relates.

"The taking of the above testimony by the defendants as stated in paragraphs 1 and 2, including also any testimony which said defendants may choose to offer on the subject-matter specified in paragraph 3, shall be concluded on or before the fifteenth day of June next.

"The complainant shall thereupon be authorized to take the testimony of not exceeding three sanitary or engineering experts as specified in paragraphs 1 and 2, including such proof as they may elect to offer on the subject-matter covered by paragraph 3, the testimony relating to these subjects to be concluded on or before the fifteenth day of August next.

"The defendants may thereupon, if they are so advised, recall in rebuttal the sanitary or engineering experts who may have been examined by them in accordance with paragraphs 1 and 2, and may also introduce rebuttal evidence relating to the subject-matter of paragraph 3, all such testimony in rebuttal to be concluded on or before the fifteenth day of September next.

"James D. Maher, Esq., of the District of Columbia, is hereby appointed a commission-

er to take and return the above-mentioned testimony, with the powers of a master in chancery as provided in the rules of this court.

"This cause is hereby restored to the docket for further argument on a day to be fixed upon the coming in of the said testimony."

Pursuant to the terms of this order the Additional Testimony has been taken and the case is on for a final hearing.

PRELIMINARY STATEMENT.

We may briefly recall the outstanding features of the proposed plan of the State of New Jersey and the Passaic Valley Sewerage Commissioners for the disposal of the sewage of the Passaic Valley. For convenience, we repeat the general outline of the situation which was set forth in the brief for the complainants on the former hearing; the references are to the Original Record.

(1) The Passaic Valley Sewerage District.

This was constituted by Laws of 1902 (New Jersey), Chapter 48, so as to comprise described portions of Essex, Passaic, Bergen and Hudson counties. It embraces most of the watershed of the Passaic River from its mouth at the head of Newark Bay to the west line of the City of Paterson. It includes the cities of Newark, Passaic, Paterson and Orange, as well as many populous boroughs and villages, or about thirty communities. The general outline of the district is a parallelogram about 17 miles long and 6 miles wide. The total area regarded as tributary to the proposed trunk sewer is about 103.2 square miles, but it should be noted that the total area covered

by the thirty communities is about 140 square miles (Vol. II, p. 1250).

The population in this district in the year 1910 was 734,396 (*id.*, p. 1251). It appears that the rate of growth of population has exceeded the estimate of the Passaic Valley Sewerage Commission, which was only 702,400 for the year 1911 and 1,649,440 for the year 1940. It has been estimated that at the present rate of growth the population in 1940 will be nearer to 2,000,000, and hence that the daily quantity of sewage to be discharged as proposed will be correspondingly increased (*id.*, pp., 1282, 1283).

By Laws of 1907 (New Jersey), Chapter 10, the Passaic Valley Sewerage Commissioners were authorized to prepare plans, etc., and to enter into contracts with the municipalities within the district. Plans for the joint intercepting sewer in question were accordingly made by the Commissioners, and by 1911 fifteen of the municipalities within the district had executed the contract for the construction of the sewer. These included the cities of Newark, Passaic and Paterson and certain boroughs and towns (Vol. III, p. 2625).

(2) Present Sewerage Conditions Within the Passaic Valley District.

The sewage of the various municipalities within the district has hitherto been received by the Passaic River. This river rises in the northern part of New Jersey, and, running in a southeasterly direction through the counties of Passaic, Bergen, Hudson and Essex, discharges its waters into Newark Bay (Vol I, p. 32). The various communities have not disposed of their sewage jointly, but separately in the usual manner. The Passaic

River has become seriously polluted, and since 1896 the question of its purification has been under consideration.

But neither the fact that the waters of the Passaic River find their way through Newark Bay and the Kill van Kull and the Arthur Kill into the Upper and Lower New York Bays, respectively, nor the importance of improving the present condition of the Passaic River, furnishes any excuse for the transfer of this polluting combination of sewage to the Upper New York Bay as proposed.

It is said in the defendants' answer (p. 36) "that all or nearly all of the sewage or other polluted matter which is discharged into the Passaic River, directly or indirectly, below the Great Falls in the City of Paterson, now passes down through the said river and thence in the Newark Bay and finally reaches and is discharged into the waters of the Bay of New York at or near Robbins Reef Light without any appreciable injury to said waters, and without causing any nuisance." This statement is completely met by the eminent scientist, Professor William T. Sedgwick, who testifies (referring to this paragraph in the answer) as follows (Vol. III, pp. 2253, 2254):

> "This statement, while plausible, is absolutely contrary to fact, for it is not true that the sewage and polluted matter discharged as described now passes down through the Passaic River, thence into Newark Bay, and finally into the waters of the Bay of New York. If it did so there would be no nuisance in the Passaic and no need for the expenditure of the vast sum contemplated by the Passaic Valley Commission. On the contrary, the facts are that the polluting matter here described is, for the most part, retained within the Passaic River, where it produces the

> nuisance which it is designed to abate, and does not even reach Newark Bay itself, still less the Kill van Kull or New York Bay. It is for this reason, in fact, that a nuisance exists within the Passaic River, and it would be much nearer the truth to state that the sewage and other polluting material referred to is now retained within that river and there partially but insufficiently purified. The Passaic River is in effect an elongated septic tank or sewage purification plant, the effluent from which is emptied first into the Newark Bay, where it is further purified and largely diluted, and from which it eventually, thus purified and diluted, finds its way into the Kill van Kull, and thence, after still further dilution and purification, into New York Bay itself."

Again, it would have been entirely feasible to relieve the conditions of the Passaic River by appropriate local treatment by each municipality. It is significant that Mr. Rudolph Hering, originally one of the engineers of the Passaic Valley Sewerage Commission, and one of the originators of the project in question (Vol. IV, p. 3116), after a comprehensive study of sewage disposal systems both in Europe and in the United States, changed his view and testified that there was a better method of treatment (Vol. III, pp. 2868, 2870). It does not even appear that the proposed method is the more economical; there is evidence to the contrary. As was said by Mr. Theodore Horton, an eminent expert (Vol. III, p. 2292), who in 1902 was in charge of the Passaic Valley trunk sewer (Vol. III, pp. 2298, 2304):

> "In my opinion, the project such as is proposed is not necessary, nor is it a desirable or economical way to dispose of the Passaic Valley sewage."

What has been accomplished in local sewage disposition is illustrated in the interesting report by Mr. Fuertes (an engineer of wide experience) to the Joint Committee of Orange, Montclair and East Orange (New Jersey) with respect to what had been accomplished at Essen and other places. He said (Vol. V, p. 4295):

> "As to the absence of nuisance around installations of properly designed Imhoff tanks the best evidence is to be found in and around the City of Essen, Germany, where numerous such plants are situated in densely populated districts. By reference to Figure 1, which is a photograph of the Essen-North plant, it will be seen that directly back of the works is a row of large buildings, several stories in height. These stand about 500 feet from the tanks treating the sewage from 180,000 people, and are high-class apartment houses. Figure 3 shows the plant at Recklinghausen, which receives the sewage from 26,000 people. This little plant stands on an area considerably less than an acre in extent, the area of the tanks being 0.05 acre and of the sludge drying beds 0.10 acre. The house close beside the plant is the residence of the superintendent of the works. On the opposite side of the works from the superintendent's house and, as I recollect the location, not more than 500 or 600 feet away, is a very fine detached residence; others are located around the same general neighborhood at various distances from the works, as can be seen in Figure 4. No complaint has ever been made of odors at this plant, nor could I learn of anyone living in the vicinity who had found anything to object to about the works."

In truth, there is no exigency whatever which can be urged in justification of this method of combining the sewage of all these communities, and,

after collecting it into a joint trunk line sewer, then discharging it into the waters of Upper New York Bay.

The point is that whatever injury the New Jersey communities may suffer through the nuisance of a polluted stream, they have sought to transfer to New York by creating in its harbor a nuisance of an intolerable character.

(3) Present conditions in New York Harbor.

The harbor of New York consists of the Lower Bay, the Upper Bay, the East River, the lower reaches of the Hudson River, the Kill van Kull, the Arthur Kill, Newark Bay and Jamaica Bay. The Lower Bay is situated at a re-entrant angle of the coast line and is a broad expanse of water open to the Atlantic Ocean. The Upper Bay is joined to the Lower Bay by a narrow channel or strait known as the Narrows. The Narrows, the Arthur Kill and the Kill van Kull are the waters which surround the Borough of Richmond, of the City of New York, commonly known as Staten Island. The Upper New York Bay is a body of water north of The Narrows into which flows the Kill van Kull, the Hudson River and the East River. Newark Bay is joined by the Arthur Kill to the Lower New York Bay and by the Kill van Kull to the Upper New York Bay, and into Newark Bay flow the Hackensack and the Passaic Rivers. The point of discharge of the proposed trunk line sewer is about five hundred feet north of Robbins Reef Light. This light is in Upper New York Bay at a distance of a little less than one mile northeast of the northeastern corner of Staten Island, or Richmond Borough, of the City of New York. It is about two miles from the Brooklyn shore and

about 3.6 miles north of Fort Wadsworth on the west side (or Staten Island side) of The Narrows.

The extraordinary contention is made by the defendants that existing condition of the Bay of New York, by reason of the sewage it already receives, deprives the State of New York of all right to complain of the vast increase in pollution to be caused through this abnormal addition of the combined sewage of the Passaic Valley. The truth is, as we conceive it, that the existing conditions in the harbor of New York, instead of depriving the complainant of a right to object, make it absolutely essential for the protection of health and commerce that no such additional pollution shall be tolerated. The fact that the waters of the Hudson and the East Rivers, which flow into New York Bay, carry the sewage of great riparian communities is a reason not for permitting this threatening addition from the Passaic Valley, but for preventing it.

At the present time there are twelve communities in the State of New Jersey discharging sewage directly into upper New York Bay, the Kill van Kull and the lower portion of the Hudson River. And there are eleven communities in the State of New York discharging sewage directly into upper New York Bay, the East River, the Harlem River and the lower portion of the Hudson River below the north line of Yonkers (Vol. II, p. 1253). The sewerages of the riparian cities of Hoboken, Weehawken and Jersey City (all in New Jersey) are very bad and largely because of a defective sewerage system (Vol. III, p. 1745). The New York Harbor waters now receive 900,000,000 gallons of sewage a day from about 6,000,000 people in its riparian communities (Vol. II, p. 1644). But, of course, this sewage is not com-

bined but is discharged into the adjacent waters at various points in a very wide area. The total deposits received from these riparian communities amount to about 1,500 tons of solid material daily, and the result is a general pollution of New York Harbor waters. All the sewage discharged into these waters from the riparian communities is what is described by the sanitary engineers as "fresh sewage." That is, the organic refuse reaches the water in from fifteen to thirty minutes after leaving the animal body (Vol. III, p. 2352).

When organic wastes are discharged into bodies of water, they are disintegrated by the functional action of bacteria into simpler elements. The character of this disintegration process is dependent upon the amount of oxygen present in the waters in a dissolved state. If the dissolved oxygen is present in sufficient quantity aerobic bacteria disintegrate the organic matter with the aid of the oxygen into harmless and simpler elements. If the oxygen content of the waters has been seriously depleted aerobic bacteria are unable to function and the work of disintegration is then completed by an-ærobic bacteria, and the decomposition products of their functional activity is dangerous to public health and injurious to property (Vol. III, p. 1939; 1996, 2257). The dangers from this latter condition are pestilence, and the destructive erosions of paints and metals on ships and other property (*id.*, pp. 1951, 1953, 1961, 1971, 2298, 2305).

The waters in New York's Upper Bay are brackish. They consist of about equal parts of salt and fresh water. Brackish waters have the lowest digestive power for organic refuse. The reason for this is that the bacteria that are effi-

cient in fresh water are either killed or rendered moribund by the presence of saline matters in the admixture of salt water, while the bacteria that flourish in salt water are either destroyed or become inert in the presence of fresh water. These facts render brackish water the least desirable for the discharge of organic refuse with a view to its final disposition therein (*id.*, pp. 1322, 1323).

The tidal range in New York Harbor is about four feet (Vol. II, pp. 1059, 1062). The tidal prism is the volume of water between high water level and low water level. The depths of water in New York Harbor are variable and only about 58% has a depth of over twelve feet (*id.*, p. 1051). Only a small portion of the water in the harbor is changed at each tidal cycle (*id.*, p. 1052). Between 72% and 80% of all the water that comes in on a flood tide is water that has already been in the harbor and went out on a preceding ebb tide heavily polluted (*id.*, pp. 1055, 1056; Vol. III, pp. 2027, 2374). The volume of water below low water level is continuously in the harbor, is heavily polluted and is subject to no refreshing action from the incoming flood waters, except what it can gain from 20% to 25% of those flood waters.

The report which has been marked "Complainant's Exhibit No. 91" sets forth the salient features of the tidal phenomena in the Harbor of New York as worked out after nearly four years of continuous study, during which all observations since 1858 were carefully studied and interpreted (Vol. II, p. 1056). For every month in the year a record was kept of the quantity of water which will return on the ebb. There were actual measurements made four times a day at stated intervals at eleven different stations throughout the harbor and were carried out continuously

(Id.). An extended series of float observations were conducted to determine the length of time sewage discharges were retained in the harbor waters prior to being deposited on the bottoms of these waters. The results shown by these float observations were that sewage matter discharged into the Hudson River took six to seven days to reach the Upper Bay of New York, and that like matter discharged into the East River averages about nine days before reaching the Upper Bay. And that of all the floating organic or other matter discharged into New York's Upper Bay and carried by the ebb to the Lower Bay, or to the Atlantic Ocean, that 75 per cent to 80 per cent returns on the incoming flood tide and adds its pollution to the already overcontaminated harbor waters (Vol. I, 895-951; Vol. II, 913-938; 1053, 1054, 1065; Vol. III, 2027, 2374).

These plotted oscillations are visualized in Complainant's Exhibits Nos. 89 and 90 (Vol. IV, p. 3388).

The harbor waters of New York are at the present time overburdened by sewage pollution from the contributions of organic matter discharged by the riparian communities thereon. This condition is apparent to even laymen using these waters for either business or pleasure purposes.

(4) The defendants' plan for a trunk sewer from the Passaic Valley to the Upper New York Bay.

There is no dispute as to the physical character of this proposed Trunk Sewer. The defendants' answer admits and shows that the plans adopted by them and submitted by them to the municipalities described:

"provide for the construction of a main intercepting sewer or sewers extending from the Great Falls of the said river in the City of Paterson, following generally the course of the said river to the City of Newark and from thence across the Newark Meadows to the Newark Bay and from thence by a tunnel to be constructed under the waters of the said bay and the lands covered by its waters and under the Cities of Bayonne and Jersey City and through the soil underlying the waters of the Bay of New York to a point in the said Bay about 500 feet north of Robbins Reef Light on the westerly side of the main ship channel in the said Bay and of the line so established, as aforesaid, dividing the territory of the two states within the said Bay of New York, and about one-quarter of one mile westerly from the said line" (p. 33).

It thus appears that the sewage, instead of being suitably treated in each municipality, is collected and combined in this trunk line, or intercepting, sewer. This combined sewage is treated together and only at one point, that is, on the Newark Meadows near Newark Bay. At that place, there is to be installed a pumping station for the purpose of obtaining a sufficient height and pressure to discharge the matter passing from it into and through the tunnel to the place or point of discharge in Upper New York Bay. The manner of treatment, and the manner of discharge, are set forth in the stipulation entered into with the Government of the United States.

"(a) Upon the line of the trunk sewer which it is proposed shall be constructed, and at a point at or near the pumping station to be located on the Newark Meadows near the Newark Bay, it is stipulated and agreed that the sewage, waste and other matter passing

through the said trunk sewer shall first pass through coarse screens to remove therefrom all large floating matter, and after passing through such coarse screens shall pass through a grit basin or basins where the heavy matter therein shall be taken out as far as practicable, from which basin or basins the sewage and other matters shall pass through self-cleansing mechanical screens having clear openings of not over 4/10 of an inch.

"(b) As the sewage comes from the fine screens, it shall also pass through sedimentation basins. The sewage after passing through said grit basin and said self-cleansing mechanical screens shall enter the sedimentation basins or settling tanks consisting of a number of units, each approximately 225 feet long and 15 feet deep. Each tank will have a normal capacity of not less than 1,250,000 gallons, making an aggregate tank capacity sufficient to meet the requirements as stated herein. The tank capacity shall always be such as to provide a detention period of not less than one hour at the maximum rate of flow of the sewage and a detention period of the daily average flow of such sewage for not less than one hour and a half. The mean lineal velocities through said tanks shall not be over 0.5 inch per second for average flow, and 0.75 inch per second for the maximum flow. In addition to and in connection with these basins scum boards shall be provided to retain the floating matter, and proper and adequate devices shall be used to remove the retained scum and deposits from the settling basins; drawings of the general plan of said settling tanks (sedimentation basins) as proposed at the outset being herewith attached as Appendix A.

"(c) The sewage and waste thus screened and settled is then to flow into a pump well, whence it is to be pumped under pressure

through a tunnel to a point in the New York Bay near Robbins Reef Light, at which point it is agreed that the matter passing through the said tunnel shall be dispersed into the waters of the New York Bay through a series of outlets discharging forty feet or more beneath the surface of the water at mean low tide. From the end of the tunnel connections shall be made with four or more discharge pipes extending across the current, spaced about one hundred feet apart, laid in trenches on the bottom of the Bay, and of a size decreasing in diameter from about six feet to two feet. On the top of these discharge pipes will be a series of not less than one hundred and fifty tees of a diameter not exceeding one foot, and spaced approximately ten feet apart. On each of these vertical tees shall be placed outlets arranged to discharge horizontally across the tidal current, and the extent of the dispersion area used for this system of outlet pipes shall cover at least 3.5 acres of the bottom of the Bay" (Complainants' Exhibit No. 135; Vol. V, pp. 4006-4007).

The stipulation also contains certain covenants that through the above-stated requirements, "or through requisite, lawful additional arrangements," certain results with respect to immunity from injury would be guaranteed.

The inadequacy of this stipulation to secure proper protection, and its complete insufficiency as a defense, is abundantly established (see Original brief for Complainants, pp. 75-85).

(5) Consequences.

It is the contention of the complainants that the discharge from the Passaic Valley trunk sewer outfall in the Upper New York Bay will create a

public nuisance injurious to the public health and comfort of the citizens of the State of New York, and particularly of the City of New York. That it will injure commerce by the formation of enormous sewage fields, giving off offensive and unwholesome emanations injurious to both health and property. That this sewage discharge will injure the hulls of vessels and wharves, docks and other structures, the property of citizens of New York. That this discharge and the poisonous gases emanating therefrom will expose our citizens, and travelers coming on business or pleasure to our City and State, to the dangers of disease, as well as annoyance and discomfort, through the excessive pollution of our harbor waters. That this discharge will either drive away or poison fish used for food that swim in the waters, or the oysters, clams and other fish that now exist in large areas throughout our harbor waters, and that it would impair and destroy the value of our fisheries, now the property of our citizens. That the dangers to public health, the injuries to property and the menace to the commercial and industrial prosperity of New York are incalculable and irreparable.

Upon the former hearing we presented the following points:

First: The complainants have established that the proposed enterprise will create a nuisance of the most serious character, injurious to health, property and commerce.

Second: The stipulation between the Passaic Valley Sewerage Commissioners and the Government of the United States wholly fails to afford assurance of protection.

THIRD: The existing condition of the waters of the Bay of New York furnishes no justification for the creation of this nuisance.

FOURTH: The State of New York is entitled to maintain this bill, and to secure the relief asked (a) upon principles which may be deemed to be applicable to controversies between States, irrespective of the compact of the year 1833 with the State of New Jersey, and (b) by virtue of the exclusive jurisdiction reserved to the State of New York under that compact.

We beg leave to refer the Court to the original brief for the complainants for a discussion of these points. Thus, in that brief (pp. 17-74) will be found a review of the evidence under the first point. The inadequacy of the stipulation is discussed in the original brief at pages 75-85. And the argument in support of the third and fourth points is set forth in the original brief at pages 86-111.

THE ADDITIONAL TESTIMONY.

Upon the supplementary hearing, the defendants called three witnesses,—George W. Fuller, Frederic P. Stearns and George C. Whipple.

There were then called three witnesses for the complainants,—Kenneth Allen, Earl B. Phelps and Olin H. Landreth.

The defendants recalled, in rebuttal, George W. Fuller.

We shall consider this Additional Testimony in relation to the subjects mentioned by the Court in its order.

FIRST.—The testimony as to "any practicable modification of the proposed system of sewage disposal of the Passaic Valley Sewerage Commissioners, either as to construction, arrangement or operation, and the nature and character of sanitary or engineering appliances that may be added thereto or introduced therein, in order to lessen the alleged polluting effect of the effluent upon the waters of New York Harbor."

It may be said, at the outset, that the complainants still adhere to the view expressed on the former hearing that the most practicable change would be the abandonment of the trunk sewer project entirely and for each municipality in the Passaic Valley District to treat its sewage locally. The Additional Testimony does not deal with this matter as the new testimony was directed, in accordance with the order, to the question of modifications of the proposed system adopted by the Passaic Valley Sewerage Commissioners.

As already stated, these Commissioners, by stipulation with the United States Government, agreed to construct on the Newark meadows near Newark Bay, a purification plant where the sewage from the Passaic Valley District would be treated before its discharge into New York Bay. The type of plant and manner of treatment of the sewage were described in the stipulation (*ante*, pp. 14-16). This manner of treatment was to pass the sewage first through coarse screens, then through grit basins, then through self-cleansing mechanical screens having clear openings of not over four-tenths of an inch, and finally through sedimentation basins, from whence the sewage and waste were to be pumped under pressure and

discharged through a series of outlets placed at the bottom of the Bay forty feet or more beneath the surface of the water at mean low tide (see Complainants' Exhibit No. 135; Original Record, Vol. V, pp. 4006-4007).

It was manifest that the representatives of the Federal Government, who concurred in the terms of this stipulation were not satisfied with these provisions as affording anything like an adequate assurance that the construction and operation of the system as thus described would constitute a protection from an unwarrantable pollution of the Bay. Accordingly the stipulation proceeded to add to the requirements contained in the description of the system the following explicit covenants:

> "Second. The Passaic Valley Sewerage Commissioners further agree with the United States that in the operation of said sewer system at all times the following results shall be secured, *either* through compliance with the requirements of the immediately preceding paragraphs, *or through requisite lawful additional arrangements, viz.*:
>
> "(1) There will be absence in the New York Bay of visible suspended particles coming from the Passaic Valley sewage.
>
> "(2) There will be absence of deposits objectionable to the Secretary of War of the United States in the New York Bay coming from the Passaic Valley sewage.
>
> "(3) There will be absence in the New York Bay and its vicinity of odors due to the putrefaction of organic matters contained in the Passaic Valley sewage thus discharged.
>
> "(4) There will be a practical absence on the surface of New York Bay of any grease or color due to the discharge of the Passaic Valley sewage at the dispersion area or elsewhere.

"(5) There will be no injury to the public health which will be occasioned by the discharge from the said sewer into the Bay of New York in the manner proposed, and no public or private nuisance will be created thereby.

"(6) The absence of injurious effect from said sewage discharge, upon the property of the United States situated in the Harbor of New York.

"(7) The absence of reduction in the dissolved oxygen contents of the waters of New York Bay, resulting from the discharge of Passaic Valley sewage, to such an extent as to interfere with major fish life."

It will thus be noted that it is not agreed that these results shall be secured "*through compliance with the requirements of the immediately preceding paragraphs*", which set forth the proposed plant and system, but that these results will be accomplished *either* through that system or through *something else which is not in any way defined.*

This *something else* which thus affords in the last analysis the sole assurance of protection is described in the covenant in paragraph Second of the stipulation above quoted as being "*requisite lawful additional arrangements*". What these might be, or would be, was not defined. Accordingly, in the original argument for the complainants it was pointed out that the promise contained in the stipulation with the Federal Government was wholly illusory (see Original Brief for Complainants, pp. 75-85). We may briefly summarize our position as to this.

The stipulation rests upon an uncertain foundation in law. It was not made under the authority of any Act of Congress. It was in connection

simply with the dismissal of the Government's intervention. As we have already urged, the scope of the authority of the Attorney-General to make agreements on the part of the United States, the basis for which is not found in any Act of Congress, but is predicated solely upon an implied authority in connection with the appearance of the United States as an intervenor in a suit between States, is far from clear. If it be recognized as an unlimited authority there is a way open to bind the United States in an unprecedented manner without the authority of any appropriate legislation by Congress. The power to regulate commerce is confided to Congress and not to the President or to the Department of Justice, and it may be added that no implication of authority on the part of the Attorney-General to dispose of an intervention in a suit to which the United States is not an original party can go so far as to destroy the State's right to protect itself in a matter in which Congress, although it may have the right to intervene, has not intervened.

Moreover, if it be said that the performance of the stipulation with the Attorney-General was subsequently made a condition of the granting of the permit by the War Department for the construction of the outlet and shaft-house in the Bay, it is sufficient to point out that the authority of the Secretary of War under the applicable statute (Act of March 3, 1899, Chap. 425, Sec. 10; 30 Stat. 1151) relates simply to physical obstructions. Congress did not attempt in this limited provision to establish and had not otherwise established,—as the Attorney-General of the United States stated before this Court upon the application for intervention—a sanitary code or plan of regula-

tion for the protection of health and commerce and with respect to nuisances of the sort here under consideration. The granting of the permit by the Secretary of War for the physical construction in the Bay, in the exercise of his jurisdiction to prevent physical obstruction to navigation, cannot in any way impair the right of the State of New York to object, not to the structure as a structure, but to the pouring out of this putrid mass into the Bay to the injury of the health and commerce of its people. We have also pointed out the uncertainty of adequate protection to the State of New York in action by Federal officers in the revocation of a permit of this description.

It must also be observed that the stipulation does not constitute an agreement with the State of New Jersey and does not purport to bind the State of New Jersey.

And, as the whole reliance of the stipulation ultimately is placed on the "*requisite lawful additional arrangements*", wholly undefined, it cannot but be concluded that the stipulation affords no protection whatever to the people of the State of New York. It is to be noted that the arrangements are "*additional*", thus emphasizing the doubt of the parties themselves with respect to their present plan. It is said that they must be "*requisite*", but there is no definition of what shall be considered requisite, and this in itself affords opportunity for a serious difference of opinion and for a dissipation of energy without the accomplishment of any useful result. Further, the provision is conditioned upon the "additional arrangements" being "*lawful*". This is of special importance in view of the fact that the stipulation is made with the Passaic Valley Sewerage Commissioners, and must be taken to mean lawful as

to their action. But their action as a body corporate is determined by the authority given them, and thus at any time the "requisite additional arrangements" may be frustrated through lack of any authority to provide them.

Furthermore, paragraph Second of the stipulation, which contains the covenant in question, cannot be deemed to be broken unless the injurious consequence described can be addressed to the particular sewage. Every subdivision of the agreement contained in paragraph Second of the stipulation contains this qualification which interposes an extreme difficulty to enforcement, if indeed it does not render enforcement of the stipulation impossible. The insuperable difficulties which thus inhere in the stipulation, as an assurance of protection to the people of New York, were made very clear by the testimony of distinguished experts—witnesses of the highest character, which was presented to this Court on the former hearing (see Original Brief for Complainants, pp. 84-85).

This being the state of the case, the defendants had this additional and unusual opportunity, after the full argument at the former hearing, to present evidence of what practicable modifications could be made in order to give assurance of the protection of the Bay from this serious pollution through the artificial introduction of this body of sewage from the Passaic Valley District.

The defendants' witness upon this point was Mr. George W. Fuller, a consulting engineer living in Summit, New Jersey. He testified as to the additional arrangements which he deemed practicable for introduction into the Passaic Valley Sewerage project. Mr. Fuller was a member of the firm of Herring & Fuller, who were at one time the chief engineers of the Passaic Valley

Sewerage Commission and had assisted in preparing in substantial outline the present plans for the disposal of the Passaic Valley sewage (Additional Testimony, p. 5). So far as the purification of the sewage was concerned by treatment works Mr. Fuller was more actively engaged in the preparation of plans than any other member of the firm (*id.* p. 27). It will be recalled that Mr. Fuller's partner, Mr. Herring, testified in behalf of complainants on the original hearing, that there was a better method of treating the Passaic Valley sewage than in the manner proposed. (Original Record, Vol. III, pp. 2868, 2870).

Mr. Fuller made six suggestions:

(1) As to the subdivision of the sedimentation tanks on the Newark meadows for the purpose of reducing the velocity of the flow of sewage through the tanks;

(2) As to the installation of very fine screens or strainers placed in the effluent waterways through which the sewage would pass from the tanks to the tunnel leading to New York Bay;

(3) As to aeration of sewage in the tunnel above the pumping-station;

(4) As to variation in the rate of pumping the sewage into the Bay;

(5) As to the use of chemical precipitants;

(6) As to the prevention of the stranding of solids in the flat-graded sewers tributary to the trunk sewer.

These six suggestions comprise the only modifications of the proposed system of sewage disposal of the Passaic Valley Sewerage Commissioners which have been presented by the defendants in response to the order of the Court. These will be considered in the order stated, the refer-

ences (except as otherwise noted) being to the record of the Additional Testimony.

(1) *The subdivision of sedimentation tanks in order to reduce the velocity of the flow of sewage through the tanks.*

Sedimentation basins are now being constructed at the plant on the Newark meadows. The purpose of the basins is to detain the flow of the sewage in order that the solid matter may settle at the bottom of the basins, from whence it is removed through hoppers constructed at the sides (Rec. pp. 12, 13). These basins have a total capacity of about 9,000,000 gallons. The inside length of each basin is about 216 feet and the velocity of flow of sewage through each of these basins was computed by Mr. Fuller to be about four-tenths of an inch per second or 120 feet per hour when the pumping of the sewage was at the rate of 120,000,000 gallons per day (*id.* p. 8). As the volume of sewage from the Passaic Valley district increases it is proposed to construct additional basins.

The first suggestion of Mr. Fuller was for the purpose of reducing the velocity of the flow of sewage through the basins. He considered that this result could be obtained by subdividing each basin or sedimentation tank into three units, each unit being approximately 72 feet in length (*id.* pp. 11, 32, 33), with the result, as testified by Mr. Fuller, that "there would then be no opportunity for doubt as to removing say 60% of total suspended matters and about 30% of the total organic matter as the record day in and day out." (*id.* p. 12). Mr. Fuller had previously testified that in his opinion the basins as now being constructed

would remove between 50% and 60% of the total suspended matter in the sewage and between 25% to 30% of the total organic matter (*id.* p. 11) so the only effect of the first additional arrangement to the plant on Newark meadows is that it is said to remove a doubt as to the contemplated performance of the sedimentation basins as they are now being constructed.

But the testimony given on the original hearing shows that Mr. Fuller was altogether too optimistic in his expectations of the total amount of suspended matter and of organic matter that would be removed by these sedimentation tanks.

Harrison P. Eddy, consulting engineer, specialist in hydraulic and sewerage work (see Original Record, Vol. II, pp. 1391 *et seq.*), who had had considerable experience with such tanks and had conducted a prolonged series of tests at similar tanks in Worcester, Massachusetts, testified (Original Record, Vol. II, p. 1441):

> "The results of sedimentation of the sewage in these tanks will vary greatly from time to time. On the average it is not likely that over 35% of the suspended matter of the sewage will be deposited in the tanks. At times their efficiency may be so high that one-half of the suspended matter will be removed, while at other times it is probable that the removal will not amount to more than 5 or 10 per cent."

Professor Charles Edward Amory Winslow, associate professor of biology, College of the City of New York, Curator of Public Health, Museum of Natural History, and lecturer on Municipal Sanitation at Columbia University, who had made a prolonged investigation of conditions in New

York harbor (Original Record, Vol. II, pp. 1640 *et seq.*), testified (*id.* p. 1650):

> "The sedimentation basins with a detention period of one and a half hours and a mean lineal velocity of one-half an inch per second would in all probability remove not over thirty per cent. of the suspended matter in the sewage and 15 per cent. of the organic matter. In actual practice the improvement would often be considerably less than this, particularly in the summer when decomposition has proceeded farthest, and when the organic matter will be most thoroughly broken up.
>
> "Under the most favorable possible conditions, the projected screens and sedimentation basins can only be expected to remove the larger floating particles to diminish the sludge deposited in the harbor by about one-third, and to diminish the putrescible organic matter in the sewage by about one-sixth. Furthermore, this one-sixth will include the most stable portion of the organic matter, while all the most putrescible portions will be discharged in solution and fine suspension."

Robert Spurr Weston, consulting sanitary engineer, who had given nine months to continuous study of the New York harbor waters and carefully considered the specifications of the Passaic Valley Sewerage Commissioners (Original Record, Vol. III, pp. 1906 *et seq.*), testified that the effluent which would be discharged after being treated in the sedimentation tanks would contain about 66% of the suspended matter originally present in the sewage (*id.* pp. 1984-88). This, of course, is equivalent to a removal of 34% of the suspended matter.

Theodore Horton, chief engineer of the New York State Department of Health, who for two

years was engaged in the preparation of the plans for the proposed Passaic Valley trunk sewerage project (Original Record, Vol. III, pp. 2291 *et seq.*), considered that the sedimentation basins would remove even a smaller portion of the total suspended matter. He testified (*id.* p. 2298):

> "The screens and sedimentation basins will remove but a small portion of the suspended and objectionable matter, probably not over 5% to 10% of the total, and probably not over 10% to 15% of the organic matters."

Emil Kuichling, sanitary and hydraulic engineer, with vast experience and two years continuous study and investigation of New York harbor conditions (Original Record, Vol. II, pp. 1241 *et seq.*), testified that in his opinion the period of sedimentation was inadequate in warm weather to secure the removal of even 30% of the suspended matter in the sewage that will enter the proposed settling tanks (*id.* p. 2717).

It is true that the defendants' witness Johnson had said on the original hearing that the total amount of suspended solids that would be removed by the proposed plant on the Newark meadows would reach to fifty per cent. or more (Original Record, Vol. III, p. 2457), but this was opposed to the statements of the most eminent and experienced witnesses, as already shown.

This testimony given on the original hearing clearly established that the efficiency of the sedimentation tanks as now being constructed is far below the standard expected to be reached by the witness Fuller. Instead of removing between 50% to 60% of the total suspended matter of the sewage and from 25% to 30% of the total organic matter as he anticipates, the weight of the evidence is

that the removal of total suspended matter would be between 30% and 40% and that there would be a corresponding decrease in the removal of organic matter. This fact is important in considering Mr. Fuller's testimony as to the efficiency of the first proposed additional arrangement. Mr. Fuller's testimony makes it plain that the only effect which he expected would be obtained by this additional arrangement was to make the supposed efficiency of the plant as *now* constructed more certain. If, therefore, as clearly appears from the original testimony, the sedimentation tanks as now constructed will only remove between 30% to 40% of the total suspended matter in the sewage it cannot reasonably be anticipated that by reducing the velocity of flow in the manner suggested by Mr. Fuller any considerably greater proportion would be removed.

Complainants' witness, Olin H. Landreth, a most eminent expert, of the engineering school of Union College, who has studied New York harbor conditions for upwards of twenty years (Rec. of Additional Testimony, Vol. II, pp. 563 *et seq.*), took sharp issue with Mr. Fuller as to the practicability of the latter's plan for the subdivision of the sedimentation basins (*id.* pp. 593, 594). Professor Landreth testified that if the sedimentation basins were divided into three parts, as suggested by Mr. Fuller, it would be necessary to introduce inlet and outlet connections between the different units, and this he considered to be impossible without imparting a high velocity to the sewage flowing from one unit to the other (*id*).

Furthermore, as was shown by Professor Landreth, it would be impossible to subdivide the sedimentation basins without occupying consider-

able space in the basins with the partition walls and with the necessary apparatus for the operation of the inlet and outlet connections. There would thus be less distance for the sewage to travel than was contemplated by Mr. Fuller, with a corresponding decrease in the efficiency of the plant (*id.*).

But even if Mr. Fuller is able to secure a reduction of velocity in the flow of the sewage through the tanks by the means proposed, it will only be of slight benefit. His testimony itself shows that he did not anticipate that this additional arrangement would have any substantial effect as to the clarification of the effluent.

Notwithstanding the criticisms and plain defects in this plan, as pointed out by Professor Landreth, Mr. Fuller insisted in his rebuttal statement upon the practicability of his plan, but at most his testimony leaves the matter in disagreement and cannot be regarded as adequate to alter the conclusions required by the original record.

(2) *The installation of fine screens between sedimentation basins and outfall tunnel in order to interrupt in hot weather the gas-lifted sludge.*

The second additional arrangement suggested by Mr. Fuller was to supplement the treatment of the sewage in the tanks by the installation of very fine screens or strainers placed in the effluent water-ways through which the sewage would pass from the tanks to the tunnel leading to New York Bay (Rec. of Additional Testimony p. 12). The purpose of these screens was explained by Mr. Fuller to guard against results which sometimes took place in very hot weather. There was a

tendency at such times for the sludge or solids which were deposited in the bottom of the sedimentation tanks to be lifted by gas and thus pass with the effluent from these tanks. Mr. Fuller considered that by the use of fine screens these gas-lifted particles of sludge could be prevented from entering the Bay.

But, as was pointed out by Professor Landreth, this proposal was merely an emergency measure for use in hot weather (*id.* p. 596) and Mr. Fuller admitted that this was the only purpose of his suggestion (*id.* p. 626). So far as the removal of suspended and organic matters from the sewage is concerned, this suggestion is of no importance. The screens are not to be used on ordinary occasions, and even in hot weather they are only suggested to prevent the sludge which has already been deposited in the bottom of the sedimentation tanks from reaching the outlet to the Bay. Whatever the amount of suspended matter which is capable of removal from the sewage by the sedimentation tanks, whether this be 60% as testified to by Mr. Fuller after the introduction of this plan of subdivision of the sedimentation tanks or the much lower percentage, which we submit may more reasonably be expected, the use of the fine screens will not carry this removal of suspended matter any further.

Moreover, when these screens are in use, Professor Landreth has shown (*id.* p. 596) that in order to accomplish the proper detention of the gas-lifted sludge the screens must be very fine, for although the original lumps or sheets of gas-lifted sludge are themselves large when they first rise to the surface they are exceedingly fragile and soon break into numerous small lumps or particles

which cannot be caught by a screen unless it is very fine. If it is fine enough to detain this broken-up gas-lifted sludge, it would be also fine enough to catch a very large amount of ordinary sludge which has not settled on the bottom of the tanks. This amount, as Professor Landreth testified, would be so large as to make it necessary that the screens be mechanically operated, self-cleansing screens, with proper appliances and means for receiving and handling this large amount of gas-lifted and ordinary sludge. And yet it is not contemplated by Mr. Fuller to introduce this necessary mechanism which would be required for the cleansing of these screens.

(3) *The aeration of sewage in the tunnel above the pumping station.*

The third suggestion of Mr. Fuller was also with regard to conditions which the witness considered might arise during very hot weather (*id.* p. 13).

Mr. Fuller completely realized the disadvantage in the treatment of sewage after it had been permitted to become decomposed and in an advanced stage of putrefaction. He proposed to remedy this defect in the trunk sewer project by blowing air into the sewage at one or more points along its line of travel from Paterson to the pumping-station on the Newark meadows (*id.* p. 13). This in Mr. Fuller's opinion would act as a preservative to the sewage and prevent putrefactive processes being established. The suggestion was not put forward by Mr. Fuller as one for immediate adoption (*id.* p. 699). He conceded that this system had never been put in actual operation as a direct working program, but testified that he

had recommended it on other occasions (*id.* p. 699).

Professor Landreth, referring to this proposal, testified that its effect would be to create a large volume of noxious odors and would be ineffectual in that the liquid which carries along the small particles would not be affected. Professor Landreth pointed out that the putrefaction of the sewage solids which are being transported down the tunnel cannot be arrested until the supporting liquid sewage has first become freely aerated by the in-blown air and not until this fully aerated liquid has in turn aerated the solids which are flowing in the liquid sewage, or at least not until the aeration has penetrated to a considerable depth from the outer surfaces of the solid particles (*id.* pp. 396, 397).

(4) *The variation in rate of pumping the sewage into New York Harbor.*

This suggestion of Mr. Fuller as to the method of operation of the pumping system at the plant on the Newark meadows was made in order to accomplish what he conceived to be two beneficial results: *First*, in order to promote higher velocities in the trunk sewer and thus eliminate the stranding of solids above the pumping-station; and, *Second*, to regulate the discharge of sewage into the harbor so that when the velocities of flow of harbor water at the dispersion area are less than they are on an average, a less quantity of sewage could be discharged into the harbor. Mr. Fuller testified that "when the velocity is abnormally low, for half an hour each way of the turn of the tide, it would be feasible to lessen the delivery of sewage, say cut it down to fifty per cent or even

less of the normal; that would tend to aid in lessening the volume of sewage meeting the less quantity of diluting water" (*id.* pp. 13, 14).

The objections to this plan were clearly stated by Professor Landreth. As to the higher velocities in a trunk sewer tunnel which Mr. Fuller proposed to obtain by a variation in the rate of pumping, Professor Landreth said (*id.* pp. 597, 598):

> "He cannot pump at a high rate without having pumped at a low rate at some time. During the period when he is pumping at a lower rate, that trunk sewer tunnel will become a sedimentation basin, and the solids will be thrown down, and they will be thrown down greatly in excess of the quantity which will be scoured out, when he increases his velocity again and gets above the normal, that is the invariable experience in sewers. Frequent tests have been made and experiments have been tried to endeavor to flush out sewers by damming up the sewers themselves, and letting the accumulated sewerage flush out the material below. It transfers the trouble from a point below the dam or place where the odor occurs to the point above it, because while that sewage is accumulating, it is also sedimentating, and is throwing down the solids. Those solids are not moved out when the velocity is increased, by moving the dam or increasing the rate of pumping, and the reason for that is that the increase in velocity is confined to the upper portion of the volume of the cross-section of the sewer. In other words, the bottom part is increased very slightly, if at all. It is the top liquid that flows off and leaves the bottom liquid at only slightly increased velocity.
>
> "You can see that in any wash basin or in any stream, that velocity of different particles in given parts of the depth diminish from the surface down to the bottom. The

highest at the surafce, the lowest at the bottom. The bottom is where the sedimentary solids will go, while the dam is being formed, or while the velocity is being reduced; but you do not return to high velocity at that part when you increase the velocity by pumping, or when you remove the dam. Consequently, it is the experience and observation repeated in frequent cases, where efforts have ben made to accomplish flushing in this way, that it accomplishes more harm than it does good, and it is inclined to transfer the trouble from below, where the flushing is sought to be, to above where the sedimentation takes place."

As to the possibility of regulating the discharge of the outflow of the sewer in the harbor waters so as to take advantage of the change in velocities caused by the tides, Professor Landreth pointed out that it would be necessary to have some means of knowing what the velocity of the tidal run was, not only at the surface where it could be observed, but forty or fifty feet deep where the velocity was quite different and often times just the opposite from what it appeared upon the surface. (*id.* p. 598).

Professor Landreth also condemned this proposal upon the ground that it would convert the sedimentation basins and the trunk sewer tunnel into what had been tried in the past, and had been abandoned almost everywhere, namely, tidal detention basins—basins intended to store up sewage until the tide was favorable to take it out and then let it go (*id.* p. 598).

In his rebuttal statement Mr. Fuller conceded that, while there was a decrease in the rate of pumping the solids, the sewage would be deposited in the bottom of the trunk sewer (*id.* p. 703),

but he considered that the scouring velocity of the sewage at the time the rate of pumping was increased would be sufficient to remove any solids which had been deposited (*id.* p. 703). Mr. Fuller admitted that it would be necessary as stated by Professor Landreth to obtain a practicable working knowledge of the moving currents of bay water at the dispersion area but considered that it was feasible to erect a terminal house or structure within twelve or fifteen hundred feet from the outlet end of the said dispersion nozzle at which an observer could be stationed who would be in telephonic communication with the pumping station at Newark Bay (*id.* p. 703-704). Mr. Fuller further disagreed with Professor Landreth as to the use of tidal detention basins and said that he had advised their adoption in a number of instances and that he considered that they had a very helpful use (*id.* pp. 704, 705).

While it thus appears that Mr. Fuller and Professor Landreth are in disagreement as to whether the proposed variation in the rate of pumping will be of practical benefit or a plain detriment, there can be no doubt as to the trivial nature of the plan suggested. Mr. Fuller himself referred to the suggestion merely "as a helpful factor in times of unusual summer conditions—perhaps not being a factor, however, for a good many years in the future." (*id.* p. 703). The proposed plan obviously has no tendency to lessen the "*polluting effect* of the effluent upon the waters of New York harbor," and it would seem that by delaying the flow of the solids in the trunk sewer it would advance their decomposition and have a tendency to increase rather than decrease the polluting effect of the sewage.

(5) *The use of chemical precipitants.*

This suggestion was also put forward by Mr. Fuller for use only in case an extraordinary condition should arise during a very hot season. By adding lime and sulphate of alumina or sulphate of iron to the sewage, as it entered the sedimentation basins, Mr. Fuller said that the classification in conjunction with the sedimentation resulting from the flow of the sewage at the basins would be promoted, and in his judgment this chemical treatment would bring the removal of the total suspended matters from sixty to eighty-five percent and of the total organic matters from about thirty to fifty percent (*id.* p. 14). But in connection with this suggestion, Mr. Fuller did not offer any plan for a change in the existing structures, or provide for the installation of any apparatus which would adequately mix the chemicals with the sewage and thus secure the desirable results which he testified could be obtained by this method of chemical precipitation. Professor Landreth pointed out that it was necessary to have proper mixing and adequate detention and sedimentation in order to secure successful results by this method of sewage clarification, requiring apparatus and changes in the present structures. Such changes were not suggested by Mr. Fuller, and there is no evidence that he considered that they would be practicable as applied to this present plant. Moreover, Mr. Fuller did not propose an increase in the number of sedimentation basins, which Professor Landreth testified would be necessary in order to provide for successful operation (*id.* p. 599).

The suggestion of Mr. Fuller as to the possibility of using chemical precipitants to increase the removal of suspended matters from the sewage was admittedly put forward as an emergency measure to be used only in hot weather (*id.* p. 706). There is no evidence that Mr. Fuller would consider this method practicable for use throughout the year. There are many factors which, while justifying the use of chemical precipitants on extraordinary occasions, would not be considered adequate if they were proposed for use during the year. The chemicals may be too expensive and the method otherwise wholly impracticable.

(6) *The prevention of the stranding of solids in the flat-graded sewers tributary to the trunk sewer.*

The last suggestion of Mr. Fuller concerning the operation of the proposed trunk sewer was as to methods of flushing the flat-graded sewers that were tributary to the trunk sewer. Three methods were suggested by Mr. Fuller, the selection of which depended upon what was most convenient for the particular sewer in question. He stated that it was feasible to apply a hose from hydrants from the water system and thus dislodge the stranded solids in the sewer. A second method deemed by Mr. Fuller to be practicable was to install what was known as a flushing gate. By closing this gate the flow of sewage is dammed up and there is accumulated a considerable head of water. When the gate is opened Mr. Fuller testified there was established a scouring velocity which he found very helpful in keeping sewers free from stranded solids. In other cases Mr. Fuller had prevented the stranding of solids by diverting water from

small brooks in the vicinity through lines connected with the sewer. (*id.* pp. 14, 15).

Professor Landreth considered that the first and third methods were effective in order to eliminate the stranding of solids but had strong objection to the second method requiring the use of flushing gates (*id.* pp. 600-601) which he said had been repeatedly tried by sewer superintendents and occasionally by engineers and that they had always been abandoned as a hopeless and expensive way of doing work which involves the necessity of constant remedying, the effect of the flushing gate being to throw down more solids than could be removed. Professor Landreth testified that many of the tributary sewers were flat-graded producing low velocities and that the resulting stranding of solids from a sanitary standpoint was highly objectionable permitting the putrefactive condition to take place and the development of obnoxious odors (*id.* p. 601).

It will be observed that of these six suggestions only *one* has reference to a structural change in the plant on the Newark meadows. This is the first suggestion for the sub-division of the sedimentation tanks, which Mr. Fuller believes will accomplish a reduction in the velocity of flow of the sewage as it passes through the tanks. Professor Landreth, while agreeing with Mr. Fuller that such a reduction of velocity is desirable, does not agree with him as to the possibility of achieving this result by the means proposed. If, however, it be assumed that such a sub-division of the sedimentation tanks would be effectual in securing a reduction in the velocity of the flow of the sewage, the only effect of this change in the proposed plant will be, in Mr. Fuller's judgment, to make

more certain the results which he expected would be obtained by the tanks if left unchanged as originally proposed. As has been abundantly established by the testimony on the original hearing, this proposed form of treatment is wholly inadequate either to bring about the results guaranteed by the Passaic Valley Sewerage Commissioners in their stipulation with the Government or to protect the people of the State of New York from the threatened injury.

Mr. Fuller's other suggestions are concerned with possible methods of operation, not with any structural changes. The "several devices", as Professor Landreth testified, "are trivial, emergency measures, and are clearly planned more to cure perfectly evident prospective defects in the Passaic Valley Disposal System, and to patch up its shortcomings, or at least to claim to patch them up, than to meet the purpose of the Court's order" permitting additional testimony to disclose "any practicable modification" to lessen the alleged polluting effect of the effluent (*id.* p. 601). The sixth suggestion as to the flushing of the sewers which are tributary to the tunnel sewer, is an admission of a serious burden thrown on the sewer tunnel and disposal works by the inadequate grades of the tributary sewers. These inadequate grades admittedly permit the disposal of sewage solids in these tributary sewers where they remain and putrefy until they are gas-lifted and flow out to the tunnel sewer, or are flushed, as Mr. Fuller suggests. In either case, they reach the sewer tunnel, not in a fresh state as would be the case if these tributary sewers had proper grades, but highly putrid and in an advanced stage of putrefaction and of course reach the disposal plant in a

much more advanced stage of putrefaction than would be the case if the sewage had reached the tunnel sewer when still fresh. In other words, the sewage reaches the main tunnel sewer from the contributary municipalities, not in a fresh state, as it would be if the tributary sewers had good grades, but in a state of advanced decomposition.

While Mr. Fuller's plan of flushing of the flat graded sewers will offer some relief at the times when these sewers are flushed, during the remainder of the time solids are being stranded and have the effect already pointed out.

The other four suggestions of Mr. Fuller are not put forward by him, and there is no evidence that they would be deemed by him practicable for continuous use throughout the year for the purpose of lessening the alleged polluting effect of the effluent upon the waters of New York harbor. They are expressly stated by him to be suggestions as to the operation of the sewerage system for use only on extraordinary occasions in very hot weather. They are purely emergency measures designed to prevent if possible a local nuisance near the vicinity of the outfall of the trunk sewer. But so far as drawing upon the depleted quantity of oxygen in the harbor is concerned, they are not adapted to minimize this certain result and are not put forward as suggestions which would have such an effect.

The second suggestion of Mr. Fuller as to the use of finer screens between the sedimentation basins and the outfall tunnel, in order to intercept in hot weather the gas lifted sludge, has admittedly no importance in increasing the quantity of suspended solids or of organic matter which will be removed by the sedimentation tanks. They are

not to be used when the sedimentation tanks are working properly, and when they are used are only intended to retain the matters which the sedimentation tanks have already once removed.

The third suggestion of Mr. Fuller as to the aeration of sewage in the trunk sewer tunnel above the pumping station is admittedly untried and plainly has not been thoroughly worked out.

The fourth suggestion as to the variation in the rate of pumping the sewage out to New York Harbor, as already pointed out, has no tendency "to lessen the alleged polluting effect of the effluent upon the waters of New York Harbor." While, if Mr. Fuller's testimony is accepted, this method of operation will tend to lessen any local nuisance in the harbor waters, the polluting effect of the effluent and the resulting exhaustion of oxygen from the harbor waters will be the same.

The fifth suggestion of Mr. Fuller as to the use of chemical precipitants is only suggested for extraordinary occasions. It may never be used at all. Except upon the occasions when this method is resorted to the effluent discharged from the sewer into the harbor will have no other purification than is made possible by the use of the sedimentation tanks and screens as proposed in the original Passaic Valley Sewage project with a possible but uncertain advantage which it is suggested by Mr. Fuller may be obtained by the subdivision of the sedimentation tanks.

So far as the purification of the effluent is concerned, before it is discharged into the harbor of New York, the additional testimony only confirms the position taken by the sanitary engineers who testified in behalf of complainants upon the original hearing, namely, that there is no practical modification of the project as adopted by the Pas-

saic Valley Sewerage Commission which will bring about a purification of the effluent to the extent demanded in the stipulation of the Passaic Valley Sewerage Commissioners with the United States Government (see Original Brief, pp. 28-57; 69-74).

It may be noted that in constructing the plant on the Newark Meadows, there have been two important deviations from the stipulation entered into with the Government.

In this stipulation it was agreed by the Passaic Valley Sewerage Commissioners that the sewage should be passed not only through coarse screens, but through "self-cleansing mechanical screens having clear openings of not over 4/10 of an inch" (Complainants' Exhibit No. 135; Original Testimony, Vol. V, pp. 4006-4007). Defendants have obtained the consent of the Government to a modification of this plan and have arranged for the construction of a different type of screen, consisting of iron bars set in staggered fashion, which give a clear space as one looks through the bars of about an eighth of an inch, but with an actual diagonal distance between the bars of one-half or three-quarters of an inch (Additional Testimony, Vol. I, p. 9). Mr. Fuller in his original testimony, which was to the effect that the new type of screens would "produce an equal amount of clarification", stated that "the actual distance diagonally from bar to bar" was about three-quarters of an inch (*id.* p. 9). In his rebuttal statement, however, he testified that he had made a mistake and that the actual diagonal distance between the bars was one-half an inch (Additional Testimony, Vol. II, pp. 685, 686).

It is not disputed that the cost of the substituted screens is about one-half the cost of the type of screens described in the stipulation with the Government (*id.* p. 716), and we submit it cannot seriously be questioned that the new screens are greatly inferior in operation to the screens originally proposed.

In the letter of the Passaic Valley Sewerage Commissioners of May 6, 1913, to Colonel William T. Rossell, of the Corps of Engineers of the United States Army, requesting permission from the Government to substitute the new screens for the type of moving screens described in the stipulation with the Government, it is not stated that the new screens would be as efficient in the removal of suspended matters from the sewage as the screens originally proposed, but reference is made to the alleged success of the new type of screens at Boston, Massachusetts, in removing material from sewage. A similar reference to the Boston sewage disposal plant was made by the witness Fuller, who said that he found the screens as actually built to be "such as generally are used at the Boston sewage disposal plants" (Additional Testimony, Vol. I, p. 9). This reference to the Boston plant was most unfortunate from the defendants' point of view, as their own witness, Mr. Frederic P. Stearns, when referring to the same plant, testified that practically no treatment was given to the sewage before it was discharged at the outlet (*id.* p. 118), and as to the screens in use at that plant stated (*id.* 118-119):

> "They have some coarse screens; I think the bars are about an inch apart, and they take out the coarse matters, very coarse matters. There was on the line of the sewer a

> grit chamber, but the use of it has been abandoned. So that practically everything, except some bits of paper and other things that are caught by the coarse screens, is discharged at the outlets".

Complainants' witness Allen produced figures as to the amount of screenings removed by the Nut Island (Boston) screen in 1918, as compared with the type of screen described in the stipulation with the Government, and he showed that whereas the average removal by the Nut Island screen was 5/100 of a cubic yard per million gallons, the average removal by the other type of screen was 34/100 of a cubic yard per million gallons, or seven times as much as was removed by the screen at Nut Island (Additional Testimony, Vol. II, p. 482).

It may also be noted that although Mr. Allen's book on "Sewage Sludge" was cited by the Passaic Valley Sewerage Commissioners in support of their application for permission to change the type of screens (Letter of Passaic Valley Sewerage Commissioners, *id.*, p. 716), Mr. Allen agreed with defendants' witness Stearns that the Nut Island screen was a coarse screen and was only designed to remove coarse material (*id.* p. 485).

Professor Landreth also clearly stated the superiority of the type of the self-cleansing mechanical screens to that which the Passaic Valley Sewerage Commissioners are planning to construct. Professor Landreth said (*id.* pp. 587-588):

> "Mr. Fuller in his testimony (stenographic minutes, page 18), conveys the impression that the coarse screens being built are substantially equivalent to the fine screens stipu-

lated, whereas the coarse screens being built simply meet the requirements of the coarse screens stipulated, and cannot at the same time perform the function demanded, of the additional finer self-cleansing mechanical screens which are stipulated but are not being furnished at all. Mr. Fuller apparently endeavors to make it appear that a coarse screen is equivalent in clarifying capacity to a coarse screen plus a finer self-cleansing mechanical screen.

"It seems hardly necessary to refute Mr. Fuller's expressed opinion (stenographic minutes, page 18), that the screens now being built which have clear openings between the bars of ¾ of an inch will produce an equal amount of clarification as the self-cleansing mechanical screens having clear openings of not over 4/10 of an inch. The finer self-cleansing mechanical screens, which are being omitted, would be superior in clarifying or screening capacity to the coarser stationary bar screens now being built, in two respects: First, because a self-cleansing mechanical screen has the power to remove or screen out of sewage many more particles and smaller particles than a stationary, vertical bar screen having the same clear openings, and, second, in addition to this the openings in the mechanical screens are smaller and the screening capacity or capacity for clarification is still further increased.

"The 4/10 inch screen stipulated would have removed from the sewage, particles of solids having only 40/75 of the diameter of particles removed by the ¾ inch screen of the same type, and would have removed particles of solids, having only 0.15 or 1/7 of the volume or weight of those removed by the ¾ inch screen. As the small solid particles of sewage constitute many times the number and many times the aggregate weight of the large particles, the small screens, even if of the

same type as the stationary bar screens, would have removed many times the weight of solids which the coarse screens now being constructed will remove from the sewage.

"The ¾ inch screens now being built are not only coarser and allow particles of sewer solids to pass which are seven times as large in volume and weight as those which could pass the 4/10-inch screen called for in the stipulations, but they are of the old style stationary type. I should say the old style hand-cleaned stationary type which, for the same clear width of opening as the self-cleansing mechanical screen will remove only a small portion of the weight of solids which the self-cleansing mechanical screens would remove."

The evidence thus shows that the Passaic Valley Sewerage Commissioners for purposes of economy have chosen to adopt a screen of far less efficiency than that described in the stipulation with the United States Government. As was clearly demonstrated on the original hearing, the plant as described in that stipulation was most inadequate for the purpose of clarification of the effluent, and it now appears that the plant which defendants are planning to construct is not even up to the efficiency of that described in the stipulation.

The second deviation from the plans described in the stipulation refers to the placing of the pumping-station. In the stipulation with the Government it is stated that the sewage will be screened and settled before it flows into a pump well, "whence it is to be pumped under pressure through a tunnel to a point in the New York Bay", etc. (*ante* pp. 15, 16). The Passaic Valley Sewerage Commissioners, however, without secur-

ing the consent of the United States Government, are constructing the pumping-station so as to intercept the sewage before it reaches the screens and the sedimentation tanks. The result of thus changing the location of the pumping-station obviously will be further to reduce the comminution of the sewage before it reaches the sedimentation tanks and thus seriously interfere with the successful operation of these tanks in procuring a settlement of the matters held in suspension by the sewage (*id.* p. 634).

SECOND.—Testimony as to "any practicable plan of sewage disposal or treatment capable of being applied to the sewage of the City of New York and the several Boroughs thereof in order to lessen the alleged polluting effect of said sewage upon the waters of New York Harbor."

There is no dispute in the testimony as to the practicable means of disposal of the sewage of New York City.

This subject has been exhaustively considered for many years by the Metropolitan Sewerage Commission and defendants' witness Stearns made no attempt to suggest any plan of sewage disposal for the City of New York which had not previously been considered by that Commission (Original Testimony, Vol. V, 4213-4264; 4447-4593).

The problem of sewage disposal for the City of New York is exceedingly complex (Additional Testimony, Vol. I, p. 356). When the distinguished scientist, Dr. Gilbert J. Fowler, of Manchester, England, was called to this country by the Metropolitan Sewerage Commission of New York for his opinion as to the practicable methods of sewage disposal, he said:

> "I was impressed at the outset by the vastness and complexity of the problem to be dealt with. London may have a larger present population but the conditions for discharge are infinitely simpler.
>
> "In addition to the rapidly increasing population directly or indirectly discharging its sewage into the harbor, the problem is complicated by the outstanding facts, viz: (1) the growing scarcity and value of unbuilt upon land in the vicinity of the harbor, (2) the com-

paratively small amount of water available for flushing out the bay, this being limited practically to the flow of the Hudson. The thickly populated districts abutting on the Harlem River and the Lower East River discharge into waters which ebb and flow with the tide, but suffer very little actual change, little or no excess water passing out of the bay or into it at each tide" (Report of Dr. Fowler to Metropolitan Sewerage Commission, Original testimony, Vol. V, p. 4548).

Because of the complexity of the problem involved, it was necessary for the Metropolitan Sewerage Commission to make exhaustive and intricate studies into the conditions of the harbor and practicable plans of sewage disposal. Dr. Fowler referred to these studies in the report which is quoted above, as follows:

"In view of the very large expenditure involved, it is difficult to exaggerate the importance of adequate preliminary studies and the work of the commission throughout appears to me to be a model of the way in which such investigations should be carried out. The conditions are so complicated, owing to the diversified character of the land and water areas constituting New York harbor and its surroundings, that endeavors to reproduce them artificially, as is often done in research work, are likely to be only partially successful. The method of thoroughly studying the actual state of things obtaining in the bay and other waters in the vicinity under all conditions of season, tide and weather, as has been done by the commission, seems the only possible one, and the work has been done with masterly completeness. No question necessary for the formation of a right judgment on the questions which should be settled at this time appears to have been left unstudied by the commission.

> "The citizens of New York may rest assured that the large sum of money they will be called upon to pay for the protection of their harbor will not be asked for except as the result of opinions formed after years of study much more complete than is generally given to such a subject. Every year, however, the conditions now existing must necessarily grow worse and, while in the case of a growing science like that of sewage disposal it is well to hasten slowly, yet through the labors of the commission there will exist no justification on the score of imperfectly known data for postponing certain most necessary works" (*id.* pp. 4548, 4549).

Under these circumstances there was little that defendants' witness Stearns could do except to endorse the plans which had been previously suggested by the Metropolitan Sewerage Commission and he did not attempt to do anything else.

There are two critical points in the sewage problem of the City of New York as it exists at the present time. The first is the condition of the Harlem River, the second is the condition of the lower East River. All the witnesses agree that the conditions in these two rivers require the taking decided action in the matter of sewage disposal. As to the Harlem River defendants' witness Stearns testified (Additional Testimony, Vol. I, p. 110):

> "I believe it must be done at once for the Harlem River. One cannot tell in regard to any particular year whether a nuisance will be created just at present, but under unfavorable conditions of hot weather and low flow, I think the Harlem River is likely to reach an intolerable condition any year now, particularly the southeasterly part."

As to the lower East River, Mr. Stearns referred to the fact that it received "a very large amount of sewage, a quantity which is increasing rapidly, owing to the growth of Brooklyn, and it is well away from the refreshing influences of the water which comes in from the ocean either through Long Island Sound or at the Narrows." (*id.* p. 110).

Complainants' witness Allen described the situation existing in these two rivers as follows (*id.* p. 294):

> "Passing from the Hudson up the Harlem River the pollution increases rapidly until at the southern end, near Willis Avenue Bridge, it is frequently very dark and turbid with oil, feces and other polluting material on the surface."
>
> "From the southern end of the Harlem River through Harlem Kills and Hell Gate, up the Upper East River to Throgg's Neck, the pollution decreases until at Whitestone Point the water is practically clean.
>
> "North of Rikers Island, however, chemical evidence has shown that the water is at times densely polluted. From Hell Gate south through the lower East River, the pollution is very bad. At times there are fields of oil from one side to the other, and at times particles of pieces may be seen in the channel of the stream as well as around the sewer outlets.
>
> "Owing to the high velocity of the current, the bottom of the lower East River is quite free from deposit in spite of the pollution; but the conditions in general are worse than in any other of the main bodies of water, except the Harlem River."

Again Mr. Allen testified as to the conditions in the East River (*id.* p. 298):

> "At Oliver Street, Manhattan, the river pollution is particularly bad. The effluent was visible at one visit more than 150 feet from the pier. Feces were seen from the Roosevelt Ferry within 300 feet from the pierhead. The river which was in view, was very dirty off Corlears Hook. Many feces were noted off Grand Street. The river was foul, dark and bubbling, and contained feces and thick scum off Division Street. In crossing at 23rd Street Ferry from midstream west, the river was very dirty with feces seen 300 feet off the 10th Street Ferry. Crossing again to Greenpoint, feces and oil were noted on the easterly side of the river."

It is not disputed that the serious conditions in these rivers cannot be relieved by any form of local treatment (*id.* p. 115).

Two plans for the relief of these rivers have been under consideration by the City of New York and there is no evidence that other plans are practicable. The first plan is called the Red Hook project, as it involves the construction of an island off Red Hook in the Upper Bay of New York. It may be divided into three parts, (1) the construction of a trunk sewer following the course of the Harlem River from 138th Street to Fordham Road and discharging the effluent into the Hudson River (*id.* pp. 362-366); (2) the construction of a similar sewer to serve the lower reaches of the Harlem River with a discharge of the effluent off Wards Island and Hell Gate (Report of Kenneth J. Allen, Additional Testimony, Vol. II, pp. 376, 377); (3) the construction of an island called Red Hook Island to be situated south of Governors Island on which a sewage disposal

plant is to be erected and a portion of the sewage which is now being discharged into the Lower East River will be discharged into the Bay at this point.

The second plan which has been proposed may be called the Ocean Island project. Under this plan the Hudson River will not be used, but all the sewage now being emptied into the Harlem River will be collected and discharged into the upper East River. The sewage from the lower East River and from Brooklyn, it is also proposed to collect and transfer to an artificial Island to be constructed about three miles south of Coney Island and there discharge the same into the Lower Bay or ocean (*id.* p. 376).

The advantage of the Red Hook Island project is that it gives greater relief to the lower East River. This, however, is accompanied by an increased pollution of the Hudson River.

The differences between the two plans were thus expressed in the report of March 16, 1918, of Kenneth Allen, Sanitary Engineer of the Board of Estimate and Apportionment of the City of New York (*id.*, p. 376):

"I—Ocean Island Project

Point of Disposal.	Sewage Flow Mgd.*	Treatment.	Equivalent Raw Sewage Mgd.
Wards Island	265	Sedimentation ...	132
Lower East River...	300	Fine screening...	250
Upper Bay	170	Fine screening...	142
Outlet Island	352	Sedimentation ...	176
Total	1087		700

Estimated cost of construction.... $41,403,000
Total annual charges 3,584,000

"II—Red Hook Island Project

Point of Disposal.	Sewage Flow Mgd.*	Treatment.	Equivalent Raw Sewage Mgd.
Hudson River at Spuyten Duyvil...	42	Fine screening...	35
Hudson River off 155th St.	81	Fine screening...	68
Hell Gate off Wards Island	142	Sedimentation ...	71
Lower East River (Isolated Plants)..	301	Sedimentation ...	150
Upper Bay (Isolated Plants)..	170	Fine screening...	142
Upper Bay off Red Hook Island..	199	Sedimentation ...	100
Rockaway Inlet off Barren Island	152	Sedimentation ...	76
Total	1087		642

Estimated cost of construction.... $32,100,000
Total annual charges ..... 2,979,000"

* Mgd. stands for million gallons per day.

Defendants' witness Stearns referred to these two plans (Additional Testimony, Vol. I. *id.* p. 114-116) and gave his preference, but he stated that his opinion was "rather an off-hand judgment" (*id.* p. 122), and was evidently made upon most inadequate knowledge of the situation. Mr. Stearns testified (*id.* p. 122):

> "Taking the waters of the Harlem westerly to the Hudson would, I think, hardly be as permanent a plan as taking it easterly toward the Long Island Sound, and therefore I will refer to the latter plan. I will have to give the best judgment I can, as rather an offhand judgment, and I should think that treatment at Ward's Island, or still better at Riker's Island, would last for twenty years without any further—that is, it would offset the diffi-

culties arising from the growth of population in New York for twenty years."

As for the plan for the relief of the East River, Mr. Stearns said:

> "The first plan suggesting the discharge south of Governor's Island, I should think would last from—I will give a range of figures—from thirteen to twenty years. The location there is not particularly good, because it is pretty near the mouth of Buttermilk Channel, and that is to an extension of the Lower East River, so that at times the water of the East River will come down there, and at other times some of that sewage would go back toward the East River, but by making that a tentative plan for thirteen or more years, the extended plan down toward the Narrows would probably meet all requirements for twenty-five or thirty years." (*id.* p. 122).

The difficulty of the problem of the Harlem and East Rivers clearly appears from the report of Mr. Fowler already referred to and contained in the original testimony (Vol. V, p. 4543). Mr. Fowler said (*id.* pp. 4553-4554):

> "As already emphasized, the first point of attack in dealing with the problem of purification of New York harbor is the Lower East river and the Harlem river, and I have given my most careful consideration to this part of the commission's work.
>
> "After much study the commission have concluded, and I think rightly, that the only point where large quantities of sewage can be treated in this neighborhood is at Ward's Island. It is possible to pick up the sewage which at present discharges into the Harlem river and also that which is turned out of

the large sewer at Hunt's Point and bring it all to Ward's Island where it can be treated in settling tanks and the heavier sludge removed.

"Some 124 million gallons daily would be thus dealt with at once, and over 400 million by 1940, and would be discharged into the swift tidal currents at Hell Gate where the best possible conditions exist for mixing.

"Sedimentation, however, leaves a large proportion of potential solids still present as well as all the impurities in solution. Treatment by chemicals instead of by plain sedimentation would remove a further proportion of the suspended impurities, but the treatment in this way of such large volumes of sewage as may be taken there involves numerous difficulties and greatly increased cost, which would weigh heavily against the advantages obtained. Further purification, by filtration, at Ward's Island is impracticable, and also not to be recommended so near large centres of population owing to the possibilities of aerial nuisance and fly trouble on large areas of filters.

"It becomes matter, therefore, for careful consideration how far the concentration of the sewage to one point and discharge into the local waters after elimination of the grosser solids would really relieve the situation. It is to this point that most careful thought has been given and the bearing of all the available data studied under every aspect.

"Owing to the fact that the waters rushing through Hell Gate only pass back and forth with the tide and do not really get away to the ocean, it is evident that whatever sewage is discharged at Hell Gate is largely dependent for its oxidation on the oxygen in the water with which it mixes in one tide. The lower East river is, however, highly polluted and the discharged effluent will therefore not get much help from it. The situation, in fact,

is only improved by the elimination of the grosser solids from the sewage of the Harlem district. If the situation is to be radically improved, the conclusion seems inevitable that some sewage must be removed from the Lower East river.

"From figures supplied me by the commission, I calculate that if the sewage of the Harlem territory is collected and passed through settlement tanks on Ward's Island, and if the sewage of those parts of Brooklyn and Queens which would ordinarily discharge into the Lower East river be removed altogether, there will then be a dilution representing 1 of raw sewage to 200 of water in the Lower East river at mean low tide.

"This is a considerable improvement on present conditions, representing a removal from the Harlem and Upper and Lower East rivers, together with about 50 per cent. of the total sewage which at present pollutes them.

"It is, however, from the Manhattan waterfront that the greatest proportional volume of sewage enters the Lower East river. It exceeds the volume discharged into this division of the harbor from Brooklyn and Queens by about 50 per cent. The further conclusion, therefore, is forced upon one that a really satisfactory solution of the problem must involve the removal of this sewage also. Indeed a study of the statistics show that if this is not done, the Lower East river in 1940, will revert to a condition even worse than exists to-day."

Leaving the difficult questions presented by the Harlem and East Rivers and coming to the situation existing in the Hudson River, defendant's witness Stearns suggested that in his opinion the condition of the Hudson would be improved by the extension of the sewers to meet the heads of

the piers. He also said that it would be very desirable that the sewage be screened before it is discharged into the river (*id.* Additional Testimony, Vol. I, p. 111). These requirements have been more than met by the plans of the City of New York.

Complainant's witness Allen described a screening plant which had been constructed under his supervision at Dyckman Street, Manhattan (*id.* p. 368), and tests which had been made at this plant of the operation of a Riensch-Wurl screen (*id.* pp. 368-370); that plans had been made for the construction of twelve such plants on the Hudson River although the witness added that, of these twelve, two of the areas probably would be combined reducing the total number to eleven (*id.* Vol. II, p. 501).

Plans have been made for the construction of six plants for the East River containing sedimentation tanks in addition to screens (*id.* p. 501).

The testimony thus establishes that New York City confronted as it is with a most difficult problem, has for many years carried on an investigation into the best possible method of meeting the situation and that it has prepared plans in accordance with the best advice which it could receive, and that the sanitary engineer called to testify by the defendants was unable to add any suggestion to the plans which had already been considered and passed upon by the City of New York.

THIRD.—Testimony "as to the present degree of pollution of the waters of New York Harbor, including those parts affected or to be affected by the proposed Passaic Valley Sewerage system and by the sewage of the City of New York; and the change, if any, in the degree of such pollution since the time to which the testimony heretofore taken relates."

It is agreed among sanitary engineers that the principal test of the pollution of water is the quantity of dissolved oxygen which it contains (Additional Testimony, Vol. I, p. 157). The effort was, therefore, made by both defendants and complainants to ascertain the variation of oxygen at different points of the harbor which had taken place since the testimony given on the original hearing.

George C. Whipple, a sanitary engineer from Cambridge, Massachusetts, testified in behalf of the defendants that on May 3, 1919, he collected samples of water at various places in the harbor and made analyses of these samples to determine, among other things, the amount of dissolved oxygen (*id.* p. 161). These results Dr. Whipple compared with those that had been obtained by him at corresponding points in the harbor on November 3, 1909 (*id.* p. 174). Dr. Whipple admitted that this comparison was not satisfactory. He himself gave the following obvious objections (*id.* p. 174):

> "Because the dates do not correspond, because the locations were only approximate, but were the best which could be made because the chlorine conditions were not quite the same; the percentages of salt and fresh water were not quite the same on the two dates."

Dr. Whipple further testified that in order to get a thoroughly satisfactory comparison it would be necessary to secure a collection and analysis of a considerable number of samples collected on different days, at different stages of the tide, and extending over a considerable interval of time (*id.* p. 175).

Although Dr. Whipple did not himself place any reliance upon the results which he obtained in this manner, the comparison is nevertheless in the record and is as follows:

At Station A, the south side of Pier A in the North or Hudson River, the amount of oxygen present on November 3, 1909, was 4.18 cu. in. per liter. On May 3, 1919, at the same place it was 4.76. The corresponding figures at a depth of 20 feet at this station were 4.17 and 4.77 (*id.* pp. 163-174).

At Station B, which was about 600 feet west of Pier A in the North or Hudson River, in 1909 the oxygen present was 4.24 at the surface. An oxygen determination was not made at the surface in 1919 at this station but at a depth of 46 feet in 1919 the oxygen present was found to be 4.67.

At Station C, which was about half way between Ellis Island and the North end of Governor's Island in 1909 the oxygen was 4.09; in 1919 it was 5.07. At this station at a depth of 63 feet it was 4.53 in 1909 and 5.45 in 1919.

At Station I, which was about 1500 feet east of Robbins Reef Lighthouse in 1909 at the surface the oxygen present was 4.97; at the same place in 1919 it was 5.52. At this station at a depth of 60 feet in 1909 it was 5.01; in 1919, 5.82.

At Station J, opposite 79th Street, Bay Ridge, and about 200 yards from the shore, on the surface in 1909 the oxygen was 4.78; at the same place, in

1919, 5.07. At this station at a depth of 34 feet, in 1909, it was 5.09; in 1919, 5.57.

At Station K, which was in the Narrows about 200 yards from shore the oxygen present in 1909 at the surface was 5.05; in 1919 5.55. At this station at a depth of 50 feet in 1909 it was 5.38; in 1919 6.12.

At Station L, also in the Narrows, in 1909 at the surface the oxygen present was 4.87; in 1919 3.10. At this station at a depth of 60 feet it was 5.32 in 1909 and 5.98 in 1919 (*id.* pp. 163-174).

On cross-examination Dr. Whipple was asked to account for the apparent increase in the amount of oxygen taken at Station A in 1919 from that found at the same station in 1909, when it was apparent that the organic burdens in the waters from which these samples were taken had been increased in the meantime. He testified (*id.* p. 190):

> "I don't undertake to account for it, because the condition of the water was not the same on the two dates with respect to the salinity, and because no two samples taken just like that, ten years apart, can fairly represent the true conditions, the true conditions of the two years. Perhaps that is the substance of my answer, that we cannot compare those two particular samples, and from that argue that the conditions are very much better in 1919 than in 1909."

This frank admission of Dr. Whipple that such a comparison as was made by him was of no value in determining the relative condition of the harbor waters in the years 1909 and 1919 should be sufficient to dispose of any argument that may be attempted upon the basis of his testimony.

We turn to the evidence given by complainants' witness Professor Phelps, whose competency and

experience cannot be questioned, which rests upon precisely the kind and "number of samples collected on different days at different stages of the tide, and extending over a considerable interval of time", which the witness Whipple said would be necessary in order to obtain "a thoroughly satisfactory comparison" (*id.* p. 175). The basis of Professor Phelps' testimony is thus explained by him (*id.* p. 508):

> "In order to determine the true conditions as accurately as possible, I have made a careful study of some two thousand, five hundred and twenty-four analyses that are in evidence in this case, covering all parts of the harbors and rivers, and extending continuously over a period of ten years. In addition, and to complete the record fully to date, I have personally examined about two hundred and ninety samples during the month of July, 1919".

The areas selected by Professor Phelps were:

(a) The Narrows or mouth of the Upper Bay;

(b) The vicinity of Robbins Reef representative of the Upper Bay;

(c) The East River from Hell Gate to the Battery;

(d) The Hudson from Spuyten Duyvil to the Battery (*id.* p. 516).

The results of his examination are expressed in the following table, which also includes a statement of the results obtained by Professor Whipple in his two examinations of November, 1909, and May, 1919 (*id.* p. 518).

NEW YORK HARBOR—DISSOLVED OXYGEN.
Summary of 2814 Examinations, 1909-1919.

Investigator and Date of Investigation.	Narrows		Robbins Reef.		East River, Battery to Hell Gate.		Hudson River, Battery to Spuyten Duyvil.	
	No. of Samp.	%Sat.	No. of Samp.	%Sat.	No. of Samp.	%Sat.	No. of Samp.	%Sat.
Whipple								
1909, Nov. 4-5	6	78	2	76	6	61	7	67
Met. Sew. Com.								
1909, Jun-July	35	83	19	74	93	65	97	73
1911, July-Sept.	132	79	117	73	217	54	345	61
1912, Jun-Sept.	56	79	12	64	57	50	57	57
1913, Jun-Sept.	158	72	53	69	239	41	145	51
N. Y. City								
1914, Jun-Sept.	16	68	2	71	96	40	94	50
1915, Jun-Sept.	16	79	4	72	83	33	76	42
1916, Jun-Sept.	16	64	6	64	44	26	54	46
1917, Jun-Sept.	24	63	6	50	54	30	44	39
1918, Jun-Sept.	6	68	4	56	6	21	8	54
Whipple								
1919, May 3	6	76	2	83	5	66	3	68
Phelps								
1919, July 7-15	8	68	4	63	32	34	42	50
1919, July 15-31	16	53	8	45	70	20	106	31
1919, July 7-31	24	58	12	51	102	24	148	36

As Dr. Whipple says, there are different methods of expressing the amount of dissolved oxygen in water. One is to give the weight of the oxygen in a certain volume of water; this is commonly described as milligrams per liter, which is approximately equivalent to parts per million. Another way is to give the cubic centimeter of oxygen per liter of water; that tells the volume of oxygen present in a given volume of water. Another way is to find the percentage of—or the per cent which the amount of oxygen present, either by weight or volume, bears to the amount which could be present if the water was saturated, either by weight or volume; that is commonly called the per cent of saturation (*id.* p. 175).

In the above table, Professor Phelps has given the percentage of saturation at the dates and places mentioned. The lower this percentage is found to be, the less oxygen there is and the greater the degree of pollution. It will be noted that these examinations show that since the year 1909 the percentage of saturation has seriously decreased, that is, the pollution of the water has greatly increased.

It will also be observed that Dr. Whipple's results were obtained in the month of November, in the year 1909, and in the month of May, 1919, whereas Professor Phelps has compared the results obtained in the months of June to September. The reason for this was explained by him to be that he desired to obtain the strictly summer conditions (*id.* p. 518); that the worst effects of pollution of waters by sewage occurred in the hot weather season (*id.* p. 520), and that if one is comparing the intensity of these critical conditions from year to year, one naturally selects the hot weather period for such comparison. Professor Phelps stated that his whole purpose in making this table was to determine whether or not the dissolved oxygen in New York harbor waters during the critical summer months was decreasing from year to year (*id.* p. 521). This he found out to be the fact (*id.* p. 522). Dr. Whipple's results for May 3, 1919, Professor Phelps stated, were distinctly out of harmony with the series of variations shown by the samples taken in the summer months and this result Professor Phelps explained as showing the pronounced effect of warm weather and illustrating the extreme importance of season and temperature as affecting dissolved oxygen conditions in the waters (*id.* p. 522).

We may also refer to Professor Landreth's clear statement upon this point, as follows (*id.* pp. 575-576):

> "In order to explain Mr. Whipple's conclusion, and show its fallacy, it is necessary first to state what I presume is already in evidence in this case, possibly in numerous places, the fact that the oxygen content, to which Mr. Whipple is here referring, of the waters, undergoes a wide seasonal annual variation periodic in nature, being greatest when the opportunities for absorption of oxygen are the greatest, and when the demands on the stored oxygen are the least. This maximum oxygen capacity occurs therefore, at or near the end of the cool season, as in the spring, because in the fall, winter and spring months there is not only a better opportunity for aeration by the disturbing effect of wind and by the incoming large diluting supplies of water from the inland streams, but there is also an almost complete suspension of the demands on the oxygen by the sludge lying in the harbor already, that demand on the oxygen being a bacterial agency, and activity, is affected by temperatures, so that the activity of these bacterial agencies during the fall and winter and spring months are almost entirely suspended, and they make little or no demand on the oxygen in the waters. From these two reasons, that is, the increased supply and reduced demand, the oxygen content shows a maximum at the end of the winter season or the spring season. In a corresponding way, the minimum of the year is produced. The warm temperatures of summer greatly increases the activities of the bacteria, which are the agencies of decomposition, and which must have oxygen for their activity, so that the demand on the oxygen is greatly increased during the summer and early fall. These also

are the periods when the least amount of diluting water and fresh incoming oxygen bearing water enter the harbor, and there follows, therefore, a well-defined minimum at the end of the season.

"Now, Mr. Whipple, in making his comparison between 1909 and 1919, has, unintentionally, perhaps, chosen a date for his earlier date in November, 1909, a point very near the minimum of oxygen content for that year. He also has chosen his later date in 1919, in May, near, if not at the point of maximum oxygen content of the harbor waters; so that, even though the harbor waters are declining year by year, both in their maximum oxygen content at favorable times of the year, and their minimum content, this comparison of Mr. Whipple's, starting at the minimum and stopping at the maximum, would very naturally and expectedly show a decided increase in oxygen content."

In addition to Professor Phelps, Kenneth Allen, an eminent sanitary engineer of the Board of Estimate and Apportionment of the City of New York, has made an examination of the progressive oxygen depletion in New York Harbor, and the results he obtained are in accord with those of Professor Phelps (*id.* pp. 319-325).

From the additional testimony taken in response to the order of the Court, it thus appears—

(1) That the State of New Jersey and the Passaic Valley Sewerage Commissioners are unable to suggest any practicable modification of the proposed system of sewage disposal which will substantially lessen the polluting effect of the effluent upon the waters of New York Harbor.

(2) That there is agreement between the complainants and defendants as to the only prac-

ticable plans of sewage disposal or treatment capable of being applied to the sewage of the City of New York.

(3) That the excessive pollution of the harbor which was demonstrated by the overwhelming proof submitted by the most eminent scientists on the original hearing has increased since that time.

These facts having been established beyond controversy, we submit, that the people of the State of New York are entitled to the relief sought.

SUMMARY.

The additional testimony, taken pursuant to the order of this Court, has only accentuated the main features of the case, as we pointed them out in our principal brief.

Here are riparian communities both in New York and New Jersey, constituting in fact a great metropolitan district, using the waters of the Bay and the adjacent waters in the natural and ordinary way for the disposal of their sewage. It is the most densely populated area in the world. It is expected that in 1960 the population of the five Boroughs of the City of New York will reach the total of 15,976,000 (Additional Testimony, Vol. I, pp. 256, 257). At this time also it is anticipated that the amount of sewage contributed by these five Boroughs to the adjacent waters will reach the total of 1,789,000,000 gallons per day (*id.*, pp. 266, 267). Added to this are the populations of Bayonne, Jersey City and Hoboken, which it is estimated will have in 1940 about 650,000 persons (*id.*, p. 265) and other New Jersey communities whose estimated populations do not appear in the record. The plans of the City of New York and of New Jersey for the disposal of its sewage cannot be limited to conditions existing at the present time, but must be arranged so as to allow for the anticipated future situation.

These communities border on New York Bay and on its adjacent waters. It cannot be denied that they have the right to use these waters for the disposal of their sewage. The State of New York is not attempting to restrain the New Jersey communities which border on the Hudson River and on New York Bay from thus disposing of their sewage. The proposition which confronts the

State of New York is entirely different. It consists in the construction of a great artificial conduit or trunk sewer which will carry organic filth and trade refuse from distant communities having no natural right to use these waters and empty the same in concentrated form at the edge of the main ship channel in Upper New York Bay. It is not necessary for the Passaic Valley Sewerage Commissioners thus to dispose of their sewage. As we have repeatedly pointed out, both on the original hearing and on this supplemental hearing, there is open to the Passaic Valley Sewerage Commissioners all the opportunities for local treatment. Land can be had where extensive purification plants may be erected and these may be situated in sparsely populated territory.

But the State of New Jersey has made no attempt to utilize these advantages which are not open to the City of New York or to the New Jersey communities bordering on the Hudson River and New York Bay, and, disregarding the welfare of the Metropolitan District as a whole, has adopted a plan which, however safe to the Passaic Valley District, is fraught with imminent danger to the communities bordering on the Bay.

If such a plan may ever be justified, it could be only by the clearest proof that the harbor waters are capable of assimilating not only the sewage, present and to be expected, from these riparian communities, but also the sewage from this Passaic Valley District as well. The State of New Jersey and the Passaic Valley Sewerage Commissioners have been afforded two opportunities to demonstrate this necessary basis for their project. But far from showing that there was no danger to the riparian communities in the carrying out of their project, those communities have affirmatively shown that exactly the opposite

would be the case. On the original hearing a long line of eminent scientists took the stand, testifying that the introduction of this vast amount of sewage from the Passaic Valley District would be accompanied by the most serious consequences to the people of the State of New York. We do not again propose to review their testimony. In our original brief (pages 27-57), we quoted many extracts from their testimony establishing the grave character of the nuisance which the defendants propose to create in New York Harbor. This testimony clearly showed, we submit, that the discharge of the Passaic Valley Sewage at Robbins Reef will create offensive conditions, giving off unwholesome emanations injurious to both health and property; that it will injure the hulls of vessel's, wharves, docks and other structures, the property of citizens of New York, and that the poisonous gases emanating therefrom will expose our citizens, and travelers coming on business and pleasure to the serious danger of disease as well as to manifest discomfort through the excessive pollution of our Harbor waters. We again refer the Court to the statements of these witnesses as found in our original brief concerning the extent and serious character of the nuisance which will be created.

On the supplementary hearing, while each of the parties was confined by the order of the Court to the testimony of three experts, this testimony establishes that the danger to the people of the State of New York in 1919 is no less great, and in fact is more so, than it was in 1909. We propose to consider this additional testimony in its relation to the effect of the discharge of the Passaic Valley sewage upon the Harbor waters in two aspects: (1) As to the effect of the effluent upon the dissolved oxygen content of the Harbor waters,

and (2) as to the effect of the proposed discharge of the Passaic Valley sewage off Robbins Reef upon the plans of the City of New York for the disposal of its sewage.

It is not denied by the defendants that the introduction of the Passaic Valley sewage in the waters of the Harbor will increase the extensive pollution now existing in those waters. It is recognized that even the most perfectly clarified effluent will make some call upon the dissolved oxygen content of the Bay. Defendants' witness Fuller testified:

> "I am aware of the fact that the most perfectly clarified sewage would make some demand, however, upon the dissolved oxygen content of the Harbor * * *" (Additional Testimony, Vol. I, p. 16).

The defendants, however, do not propose to discharge "the most perfectly clarified sewage" into the waters of the Harbor. On the contrary, this sewage, collected from about thirty communities and transferred for great distances, will be discharged in the Bay with no other treatment than is provided by the plant being constructed on the Newark Meadows. The inadequacy of this plant for the purpose of clarification of sewage was fully demonstrated on the original hearing. It was there shown that by far the greater proportion of polluting material would pass through the sedimentation basins and screens proposed to be constructed and would be discharged in concentrated form in the Upper Bay. It now appears upon the supplemental hearing that the plant as it is being constructed is not as efficient as the plant described in the stipulation and which, it was assumed by the witnesses who testified on the original hearing, would be constructed. Instead

of installing self-cleansing mechanical screens, it now appears that the defendants are planning, for purposes of economy, to use a different type of screen which the evidence overwhelmingly demonstrates is inferior in operation. Instead of placing the pumping station at the end of the sedimentation period, the defendants are planning to place this station before the sewage reaches the sedimentation tanks, thus reducing the efficiency of these tanks in removing suspended matters from the sewage.

Not only, however, was the plant as originally proposed wholly inadequate and not only is the plant as it is now being constructed more inadequate than that originally proposed, but the evidence shows that the defendants are unable to suggest any "additional arrangements" which may be introduced into the Passaic Valley sewage system which will afford a substantial increase in the clarifying power of the plant. It must therefore be taken that the proposal of the defendants contemplates the discharge into the Upper Bay of a vast amount of sewage amounting, when the sewer is in operation, to 120,000,000 gallons per day and in the near future to 360,000,000 gallons per day, without any other form of treatment than has been proposed by the defendants and which the evidence shows would fail to remove the larger portion of the polluting material in this sewage. More than that, it must be taken to be established that the defendants know of no practicable means for improving the efficiency of their treatment works, so as to reduce to a substantial extent the polluting effect of the effluent as it is discharged into the Harbor.

It is not necessary that the record should contain an exact estimate of the amount of oxygen which will be demanded of the Harbor waters for

the assimilation of this sewage. It is obvious that this quantity is large and there is small danger that it will be over-estimated. One need only consider the present condition of the Passaic River and reflect that it is the same sewage which has produced this condition, which it is proposed to discharge in concentrated form in Upper New York Bay. That the demand of this sewage upon the oxygen content of the Bay will be great seems to us clear beyond question.

In the report of Messrs. Herring & Fuller to the Passaic Valley Sewerage Commissioners, dated December 31, 1907, the condition of the sewage is thus described (Additional Testimony, Vol. I, p. 83).

> "The indications are under present conditions that the sewage as it reaches the pumping station on the Newark Meadows will normally be devoid of dissolved oxygen. From the foregoing result it seems quite plain that even though the discharges of the several outlets contribute considerable dissolved oxygen, this will be quite speedily absorbed. In its travel of twenty miles in some ten hours, it will become septic, but the more or less constant addition along the route of sewage containing dissolved oxygen, will retard rapid putrefaction. As received at the pumping station the sewage will doubtless be septic and blackened."

What then is the condition of the Harbor waters as respects their ability to assimilate this vast increase in pollution? We have already referred to the fact that the principal test used by sanitary engineers for the discovery of the ability of waters to assimilate sewage is by the determination of the oxygen content of these waters. We have also referred to the exhaustive studies which have been made and which are in evidence in this case

showing the oxygen content of the waters of New York Harbor. These results were graphically stated by Professor Phelps and appear in the table which he prepared and introduced in evidence showing the depletion of oxygen in the Harbor between the years 1909 and 1919 (see *ante*, p. 65). This table shows that in July, 1919, the oxygen content of the waters at the Narrows varied from 53% to 68% of saturation; at Robbins Reef from 45% to 63% of saturation, in the East River from 20% to 34% and in the Hudson River from 31% to 50% (Additional Testimony, Vol. II, p. 518). The results obtained by Professor Phelps can not be questioned. There is no evidence in the case upon which it may be said that the amount of dissolved oxygen present in the Harbor waters is different from that testified to by him. The testimony of Dr. Whipple obviously offers no basis for a conclusion as to the oxygen content of the Harbor.

The facts being established as to the present pollution of the Harbor and as to the amount of oxygen which the waters of the Harbor contain, there remains the question whether it is permissible further to deplete this quantity of oxygen by the introduction of the Passaic Valley sewage. It is necessary that definite standards be adopted. Professor Phelps testified that the amount of dissolved oxygen in the Harbor should not be reduced below 70% of saturation,—a point which has already been reached and exceeded (Additional Testimony, Vol. II, pp. 525, 527, 528, 549). In reaching this limitation as to the permissible depletion of oxygen, Professor Phelps stated that he had the fact definitely in mind that some of the parts of the Harbor would be unavoidably much below this figure (*id.*, p. 530).

This is the same standard which was adopted by the Passaic Valley Sewerage Commissioners in their stipulation with the United States Government. The seventh result which these Commissioners covenanted would be secured by the operation of their proposed system is as follows:

> "(7) The absence of reduction in the dissolved oxygen content of the waters of New York Bay, resulting from the discharge of Passaic Valley sewage, to such an extent as to interfere with major fish life."

This provision of the stipulation is not only an attempted agreement as to the standard by which the Passaic Valley project should be judged but a recognition of the fact that the defendants should not be permitted to discharge the sewage of the Passaic Valley into the waters of the Bay if such a discharge will reduce the oxygen content of the bay *"to such an extent as to interfere with major fish life."* That this will be the case, we submit, is not open to question.

The percentage of dissolved oxygen which is required for the support of major fish life, has been estimated at 70% of saturation (Additional Testimony, Vol. II, p. 549). This is the same percentage of saturation which has been fixed by Professor Phelps as the limit beyond which it should not be permissible to carry the depletion of oxygen in the Harbor waters. This limit, as has been abundantly shown, has not only been reached by the existing pollution, but has been in fact exceeded (*id.*, p. 527). The Passaic Valley Sewerage Commissioners are plainly therefore unable to secure either by the existing plant or by additional arrangements the seventh result covenanted to be secured by them. It cannot be pretended that the introduction of this vast amount of sew-

age will improve the condition of the Harbor waters. If, as the testimony of Professor Phelps clearly shows, the sewage from New York City and the New Jersey communities bordering on the Harbor waters has already overburdened these waters by pollution, so that they will not now support major fish life, obviously there is no room for the Passaic Valley sewage in addition if this standard is to be maintained.

Defendants, in full recognition of this obvious fact, have turned their backs upon the standard which they agreed would be reached in their stipulation with the Government and now contend that it is permissible to reduce the oxygen content of the Bay to 25% or 30% of saturation. This suggestion is highly significant of the worthlessness of the stipulation with the United States Government as a means of affording protection to the people of New York. Not only is there no intention on the part of the Passaic Valley Sewerage Commissioners to secure the result specified in paragraph 7 of the stipulation, but in the testimony in the present case the standards fixed by that stipulation are opposed as not even proper to be insisted upon by the people of the State of New York. The testimony by which the defendants seek to justify the additional pollution of the Harbor thus proceeds upon an assumption which is in direct conflict with one of the results which was agreed would be secured by them in their stipulation with the United States Government.

Thus, Mr. Fuller expressly based his testimony to the effect that the Habor waters could assimilate the sewage of fifteen million to twenty million people (Additional Testimony, Vol. I, p. 18) upon a consideration of "my own dissolved oxygen quantity of about 25 per cent. as against the

70 per cent. factor of Professor Phelps" (*id.*, p. 48).

Mr. Fuller plainly recognized that if the average amount of oxygen in the Harbor waters is reduced to such a low figure, the condition of the waters at critical areas would be even more devoid of the necessary oxygen. Mr. Fuller, however, considered: "If you have some dissolved oxygen at all times in every portion of a body of water, there will not be any nuisance arising from putrefaction" (*id.*, pp. 16, 17). The fallacy in this contention, which forms the basis of Mr. Fuller's testimony as to the permissible depletion of the oxygen content of the Harbor waters, was plainly demonstrated by Professor Phelps. He conducted a number of experiments with the view of determining the accuracy of Mr. Fuller's statement that there would be no nuisance as long as there was any dissolved oxygen in the water. He testified (Additional Testimony, Vol. II, pp. 530, 531):

> "it is not true as has been contended that no nuisance can occur as long as there is any dissolved oxygen present. To obtain data upon this point, supplementing that which I have previously testified to in the case, I have been careful to note the odors of various samples of the waters, especially in the East River. On July 22nd, when the dissolved oxygen at Pier 10 was 16 per cent, I recorded in my notes a strong musty odor of sewage origin. On July 18th, at the same station, the odor recorded was 'distinctly sewage.' The oxygen was 11 per cent.
>
> "On July 22nd, I made a trip up Newark Bay, between the hours of 10:00 a.m. and 1:00 p.m. The tide was nearing the end of the ebb. The water was noticeably discolored in the Kill Von Kull, a fact attributed at first to local pollution, until it was observed

that the discoloration was continuous and continuously increasing as we proceeded.

"A surface sample was taken at the Centreville Light. The odor was 'strong, musty,' as recorded by myself,

* * * * * *

"The dissolved oxygen was 11 per cent. At the Lehigh Valley Railroad Bridge, the odor of sewage was noticeable from the boat and was commented upon by all of the party. The oxygen value was 6 per cent, and the recorded odor of the bottle sample 'strong sewage.'

* * * * * *

"At the next stop, Central Railroad Bridge, in the Passaic River, Newark Branch, the odor from the sufrace was nauseating and the bottle sample was recorded 'strong offensive,' * * *

"Q. Did you yourself personally note the strong offensive odor from the river? A. I did, the dissolved oxygen was 5 per cent.

"Q. At the time when you noted this strong offensive odor? A. Yes, sir."

Professor Phelps' conclusion was (*id.* p. 534):

"Estimates of permissible pollution based upon an assumption of total oxygen depletion are entirely inadmissible because of the inevitable association of this condition with nuisance. My special studies of this point during the present summer have confirmed the opinion that I had previously formed that definite nuisance, including the discoloration of the waters as a whole and the evolution of offensive odors are likely to occur when the dissolved oxygen reaches as low a figure as 15 per cent and that nauseating conditions are compatible with a dissolved oxygen value of five per cent.

Estimates or assumptions as to the extent of reaeration under conditions of total depletion are therefore irrelevant.

We submit that Mr. Fuller's "own dissolved oxygen quantity of about 25% as against the 70% factor of Professor Phelps" is wholly unwarranted.

Defendants' witness, Stearns, apparently agreed with Mr. Fuller as to the ultimate population which he considered could be taken care of by the waters of New York Harbor, and stated that in his opinion this was in the neighborhood of 15,000,000 (*id.* p. 123), but Mr. Stearns was also considering a permissible depletion of the oxygen content of the Harbor waters to twenty or thirty per cent. saturation (*id.* pp. 144, 145) and his testimony, therefore, carries the matter no further than did that of Mr. Fuller.

Moreover, Mr. Stearns testified that in his opinion the place of ultimate disposal of New York sewage was the ocean (*id.* p. 123) and that in his opinion it would be wise for New York City to dispose of its sewage in the ocean rather than to attempt to utilize fully the alleged digestive capacity of New York Harbor long before the population of the City of New York should reach 15,000,000 persons (*id.* p. 124).

The only permissible conclusion from the testimony of this witness is that New York should carry its sewage out into the ocean in order to permit the distant communities of the Passaic Valley to utilize the alleged digestive capacity of the Harbor. We are unable to conceive of any principle upon which such an extraordinary conclusion could be reached.

Defendants' witness, Whipple, gave the following opinion as to the capacity of the Harbor to assimilate sewage (*id.* p. 179):

> "it has seemed to me that from a study of the dissolved oxygen conditions the water

> entering the Harbor contains enough oxygen to dispose, without nuisance, of the population which would vary all the way from 7,500,000 to 30,000,000 people according to the standard which was set, and in my judgment the fair estimate will be much nearer 30,000,000 than it would be 7,500,000."

Upon cross-examination he further explained how he arrived at the view that the Harbor waters were capable of assimilating the sewage from 30,000,000 people. He stated that there was sufficient oxygen in the new water from the ocean and from the Hudson River to supply oxygen for the sewage of 15,000,000 people. This figure he then doubled because of an alleged effect of reaeration (*id.* pp. 222, 223).

The vague character of this factor of reaeration, which is merely the taking up of oxygen in the air by a given body of water, is apparent from Dr. Whipple's own statement. He testified (*id.* p. 223):

> "I believe that no one can tell how much oxygen will be absorbed from the air, because no one has any way of finding out the movements which occur in the water, but I believe that the oxygen absorbed from the air in the process of re-aeration, is a very important factor, in the problem, and one which will increase in importance as the oxygen in the water of the Harbor becomes depleted."

It is upon this theory, because the witness believed "that the oxygen absorbed from the air in the process of re-aeration, is a very important factor," that he doubled his estimate of 15,000,000 persons and placed the estimate at 30,000,000.

Moreover, in order to reach the assumption of 15,000,000 persons, the witness assumed that the sewage would be evenly distributed throughout

the Harbor. Neither of these assumptions was made by any other witness and both were obviously opposed to the facts.

Professor Phelps completely demonstrated the fallacies underlying Dr. Whipple's testimony. He stated (Additional Testimony, Vol. II, pp. 524, 525):

> "Professor Whipple has attempted such an estimate, and expresses the opinion that the sewage from between 7.5 and 30 million people may be discharged into these waters without nuisance (page 404, stenographic minutes).
>
> "Under cross-examination (page 500 of stenographic minutes), he said that this estimate was 'based on the well-known fact that four cubic feet of water per second for each 1,000 persons is regarded as a sufficient dilution to prevent nuisance during the summer conditions.' He further assumes (page 501, stenographic minutes) that all the oxygen entering the Narrows is available for sewage oxidation in the bay and rivers.'
>
> "Neither of these assumptions is justified in fact. Four cubic feet per second per 1,000 persons, is a figure for running streams where reaeration is active, and includes the reaeration effect. I have made an extensive study of reaeration conditions in New York Harbor, and also in the Ohio River. My data show conclusively that as compared with river conditions, the deep and relatively quiescent waters of New York Harbor are subject to relatively little reaeration.
>
> "The assumption that all the oxygen entering the Narrows is available is also fallacious. In the first place it would be inconceivable that a condition like that now existing in the Passaic River would be tolerated in New York Bay. To say that the Bay can dispose without nuisance of an amount of sewage calculated to exhaust all its oxygen,

is a contradiction of terms. Moreover, the water entering the Narrows is not distributed uniformly over the Upper Bay and rivers, and long before the complete exhaustion of oxygen is reached near the Narrows, the upper harbor waters will have become entirely anaerobic. A casual inspection of any of the oxygen figures in evidence will make this fact plain. The depletion of oxygen is least at the Narrows and increases upstream.

"Upon these assumptions Professor Whipple arrives at a population of fifteen million people as a safe upper limit. This value he doubles for reaeration (page 501 of stenographic minutes), although stating (page 502, stenographic minutes) that 'no one can tell how much oxygen will be absorbed from the air,' and overlooking the obvious fact that his initial datum of four second feet of diluting water per 1,000 population is for rivers, and already includes a reaeration effect admittedly greater than that in the harbor.

"In 1910, in a report to the Board of Estimate and Apportionment of New York City, which is Complainants' Exhibit No. 136 in this case, Colonel Black and I computed the capacity of New York Harbor to receive and oxidize sewage without too great a reduction of the dissolved oxygen. We concluded that if all the sewage could be discharged at the Narrows, which is equivalent to assuming a uniform admixture of the sewage in the entire tidal flow, the sewage from 7.4 million people could be discharged without depleting the oxygen of the harbor below 70%. We estimated, on the basis of a most careful study of reaeration, that this 30% depletion would be accompanied by reaeration, equivalent to about one per cent. of the saturation value."

Professor Whipple's assumption that as the oxygen in the Harbor was decreased the aeration

factor upon which he placed so much emphasis would counteract the decrease in the oxygen was further demonstrated to be unwarranted by Professor Phelps. The latter testified that "as the oxygen is decreased, the normal digestive reactions are slackened and the reactions leading to putrefactive conditions are accelerated" (*id.* p. 524). This opinion is borne out by the fact that there has been a decrease in the oxygen content of the waters since 1909 and Professor Phelps said, "evidently the depletion is increasing at a more rapid rate than the population increases. This is what would be anticipated and illustrates the futility of basing a measure of the capacity of the Harbor to digest sewage upon an assumption of anything like complete depletion" (*id.* p. 524).

But it will also be noted that, notwithstanding the fact that defendants' witnesses proceed upon an assumption of oxygen depletion far below that necessary for the safety of the people of New York, and far below that agreed upon by the Passaic Valley Sewerage Commissioners in their stipulation with the Government, they are even then only able to assert that a population of 15,000,000 persons may safely discharge their sewage into the waters of the Bay. The population of greater New York is expected by 1960 to reach the total of 15,976,000 persons (Additional Testimony, Vol. I, p. 255). The plans of New York City for the disposal of its sewage are based upon this estimated increase in population (*id.* 265). Added to this population must be considered the large number of persons who do not live in New York, but whose business is in New York, and the great number of persons living on the New Jersey shore of the Hudson River and also on the Bay.

The plans of the Passaic Valley Sewerage Commissioners look forward to 1940. This case may not be decided solely upon the situation as it exists at the present time, although this situation, we insist, demonstrates that the people of New York are entitled to the relief sought. But, if it be assumed that a lower factor of safety should be adopted than that urged by Professor Phelps and that agreed upon by the Passaic Valley Sewerage Commissioners, even this would not justify the proposed project. The Harbor waters should be preserved for the people living on these waters to answer their requirements, not only at the present time, but for the future. It would be a monstrous thing, we submit, to hold that the Passaic Valley Sewerage Commissioners may forestall the needs of the people bordering on the Bay.

To summarize: The evidence shows that the present pollution of the Harbor is such that in the summer months the oxygen content is already below 70% of saturation; that this amount should be the standard which should be maintained by the municipalities discharging their sewage in the Harbor waters; that this is the standard which the Passaic Valley Sewerage Commissioners have agreed to adopt in their stipulation with the Government and according to which they have agreed that the success of their project should be judged. It is abundantly shown, and there has been no attempt upon the part of the defendants to show the contrary, that the introduction of this enormous mass of sewage from the Passaic Valley will reduce the oxygen content of the Harbor below this necessary factor for safety. On the contrary, the defendants practically concede that the in-

troduction of this sewage will lower the oxygen content and urge in justification of their project such a low limit as to be obviously impracticable. But even by thus reducing the oxygen content of the Harbor to a limit which we submit cannot be justified upon any theory of safety to the people surrounding the Bay, the defendants' witnesses reach the conclusion that the waters of the Bay may assimilate the sewage of only 15,000,000 persons, which is less than the number of persons which it is anticipated in the near future will discharge their sewage into the Bay even if this Passaic Valley sewerage project is not carried into execution. We submit, therefore, it is clearly established that the capacity of the Harbor waters to assimilate sewage is not sufficient to take care of both the communities bordering on these waters and the Passaic Valley District and upon the most obvious principles the Passaic Valley Sewerage Commissioners should adopt some other method of disposing of their sewage which the evidence shows is not only practicable but is more feasible and economical from their own point of view than the system which they are now attempting to carry into effect.

The second aspect in which the proposed plan of the Passaic Valley Sewerage Commissioners may be considered, is with reference to the plans of the City of New York for the disposal of its sewage. Reference has been made to the fact that the critical points in the sewage problem of the City of New York are the conditions of the Harlem and East rivers. Two plans, which have been under consideration by the City of New York for

the alleviation of the condition of these rivers, have also been mentioned. The first plan involves the construction of an island south of Governors Island and off Red Hook and the discharge of sewage, which is now emptying in the East River, at the rate of 200,000,000 gallons per day off this point. The second plan involves the construction of an island in the ocean and the discharge of sewage from this island. Whichever of these plans is adopted, the Passaic Valley sewage should not be permitted to be discharged off Robbins Reef.

The Red Hook Island project is more economical to the City of New York. If it is decided that this is the best plan to be adopted, New York certainly has a preferential right to discharge its sewage from the East River in the waters of the Bay as opposed to the municipalities situated in the Passaic Valley. The sewage which the City of New York proposes to discharge off Red Hook is now being discharged into the East River. This sewage is not additional sewage so far as the Harbor waters are concerned. It is contributed by communities bordering on the Bay or its adjacent waters and the natural outlet for the sewage from these communities is these waters.

The purpose of the City of New York with regard to the Red Hook project is merely to alleviate a local nuisance in the East River by the transfer of the sewage to another place in the waters surrounding New York better adapted to the assimilation of sewage. This situation would be similar with respect to New Jersey if Hoboken were planning to transfer a part of its sewage to Constable Hook and there to discharge the same into the waters of New York Bay. Whatever sew-

age would be added directly to the waters of the Bay off Constable Hook would have been taken from the waters of the Hudson River and the resulting pollution of the Harbor as a whole would not have been increased.

The feasibility of the Red Hook Island project of the City of New York depends very largely upon the question whether the sewage of the Passaic Valley district is discharged into the upper bay (Additional Testimony, Vol. II, p. 376). The distance between Robbins Reef and the proposed location of Red Hook Island is not great. It is apparent that if the Passaic Valley sewage is discharged off Robbins Reef and a large part of the New York sewage is discharged off Red Hook, the pollution of this area of the Harbor will be extreme. There is no evidence upon which it could possibly be regarded as practicable even at the present time—let alone conditions in the future—for New York to discharge part of its sewage off Red Hook and for New Jersey to discharge the sewage of the Passaic Valley off Robbins Reef simultaneously and without nuisance.

It certainly cannot be contended, as defendant's witness, Stearns, seems to contend, that New York should transfer its sewage to the ocean in order to make room in the Bay for the sewage of the Passaic Valley. The difference in cost between the proposed ocean island project and the Red Hook Island project is many millions of dollars. Upon no principle can it be said that this additional expense should be undergone by the citizens of New York in order to accommodate the sewage of the Passaic Valley.

If New York is to be forced to take part of its sewage to the ocean it should not be that the only

result achieved thereby would be to afford a receptacle for the sewage of the Passaic Valley. If the citizens of New York take upon themselves the construction of an island in the ocean for the disposal of their sewage, in order to preserve the Bay reasonably free from pollution, this is certainly no reason for the Passaic Valley Sewerage Commissioners, by lowering the standard conceived by the City of New York to be proper for safety, to dump the entire filth of the Passaic Valley into the same harbor that New York is attempting to keep clear of sewage.

Whichever project, then, for the alleviation of the conditions of the Harlem and East rivers is adopted by the State of New York, there is the same result so far as the execution of the Passaic Valley scheme is concerned. If the Red Hook Island project is adopted the nearness of the outlet to the point of the Passaic Valley discharge is such as to condemn the project of the Passaic Valley Sewerage Commissioners immediately. If, on the other hand, New York adopts the project for the disposal of part of its sewage in the ocean, in order to keep the Bay free from pollution, this purpose may not be thwarted by holding that its only effect is to make room in the Bay for the sewage of the Passaic Valley.

But, apart from these proposed plans of the City of New York, there is not sufficient assimilative power, as has been abundantly shown, in the waters of the Bay to take care of the sewage of the riparian communities and the sewage of the Passaic Valley as well. The present condition of the waters of New York Harbor is due, as Professor Phelps states, to "the unavoidable result

of the admixture of a specified amount of sewage pollution with the available body of water" (Additional testimony, Vol. II, 535).

Obviously, neither the Passaic Valley Sewerage Commissioners nor the State of New York can increase "the available body of water." It is necessary for them to decrease the admixture "of sewage pollution."

The State of New Jersey, instead of unnecessarily attempting to increase the difficulties of the metropolitan area bordering on the waters of the Bay, by the introduction of this vast amount of sewage from the Passaic Valley, should join with the State of New York in its endeavor to secure some improvement in the present condition of the Bay. We submit that the right of the People of New York to an injunction against the proposed trunk sewer project is clear.

A graver case could not be submitted to the determination of this Court in the exercise of its original jurisdiction. It is more important than boundaries or the ordinary exigencies of government. It relates to the commerce of our most important harbor, but it concerns that which underlies commerce and activity—the very health and life of the people of our greatest city. The situation is difficult enough by reason of the constant and rapid growth of the metropolis,—a growth in the benefits of which the neighboring communities of New Jersey have their full share. The difficulty of taking care of the sewage and waste of this vast metropolitan population should not be increased by bringing to the harbor of New York the pollution of communities many miles away, which should find their own methods of treatment

and disposition. Certainly, the communities of the Passaic Valley, not only having at their command the means of local disposition but the fully adequate opportunities afforded by the vast expanse of Newark Bay and the Newark Meadows, should not be permitted to transport their accumulated filth to the waters of New York Bay.

The State of New York asks the interposition of this Court in the protection of the vital necessities of the port of New York.

Respectfully submitted,
CHARLES D. NEWTON,
Attorney General of the State
of New York,
for Complainants.

CHARLES E. HUGHES,
WILLIAM J. O'SULLIVAN,
RUSSELL LORD TARBOX,
ALLEN S. HUBBARD,
of Counsel.

FILED
FEB 5 1917
JAMES D. MAHER
CLERK

In the

Supreme Court of the United States

October Term, 1916.

No. 2, Original.

IN EQUITY.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,

vs.

STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

Reply of defendants to motion on behalf of the complainants, the People of the State of New York, to set a day certain for the hearing of argument herein.

JOHN W. WESCOTT,
Attorney General of New Jersey.

ROBERT H. McCARTER,
Special Counsel for New Jersey.

ADRIAN RIKER,
Counsel for Passaic Valley Sewerage Commissioners.

Arthur W. Cook, Law Printer, 813 Market Street, Newark, N. J.

In the

Supreme Court of the United States

October Term, 1916.

No. 3, Original.

IN EQUITY.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,

vs.

STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS,
Defendants.

Reply of defendants to motion on behalf of the complainants, the People of the State of New York, to set a day certain for the hearing of argument herein.

To the Honorable the Chief Justice of the United States and the Associate Justices of the Supreme Court of the United States.

Come now the State of New Jersey, by Robert H. McCarter, Special Counsel, and Passaic Valley Sewerage Commissioners, by Adrian Riker, its counsel, and say:

That defendants have been and are now desirous to have this cause set down for hearing upon the pleadings, testimony and exhibits, as prayed for by the complainants, and join in the application on behalf of complainants for an order fixing a day certain for the hearing of argument by counsel for the parties hereto.

Defendants by their counsel pray that the argument herein shall not be set down as requested by complainants for a day early in the month of April, 1917, for the reason that no copy of the record has been served upon or received by counsel for the State of New Jersey up to this time, and because the said printed record was not served upon the counsel for the State of New Jersey until November, 1916; that said printed record consists of five volumes, containing over 4600 pages, beside exhibits, and cannot be properly digested, analyzed and briefed within the time named in the motion of complainants in this cause; and for the further reason that it will appear by the record in this cause that the taking of testimony was completed by the first day of March, 1913, and the printing of the record was delayed by complainants until November, 1916, notwithstanding the fact that under date of October 15, 1914, motion was made to this Honorable Court to dismiss the bill of complaint for want of prosecution.

Defendants further submit that no special cause for now hurrying the disposition of this matter exists, and therefore respectfully pray that the day for argument herein be set as early in the next term of this Court as may meet the convenience of the Court.

JOHN W. WESCOTT,
Attorney General of New Jersey.

ROBERT H. McCARTER,
Special Counsel for New Jersey.
Prudential Building, Newark, N. J.

ADRIAN RIKER,
Counsel for Passaic Valley Sewerage Commissioners.
Lawyers Building, Newark, N. J.

Office Supreme Court, U. S.
FILED
JAN 31 1917
JAMES D. MAHER
CLERK

IN THE

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1916.

No. 2 Original.

IN EQUITY.

THE PEOPLE OF THE STATE OF NEW YORK, COMPLAINANTS,

vs.

STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS, DEFENDANTS.

(1) Notice of Motion on Behalf of the Complainants, The People of the State of New York, to Set a Day Certain for the Hearing of Argument Herein.

(2) Motion on Behalf of the Complainants, The People of the State of New York, to Set a Day Certain for the Hearing of Argument Herein.

EGBURT E. WOODBURY,
Attorney General of the State of New York.

WILLIAM J. O'SULLIVAN,
Special Counsel for Complainants.

IN THE

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1916.

No. 3, Original.

IN EQUITY.

THE PEOPLE OF THE STATE OF NEW YORK, COMPLAINANTS,

vs.

STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS, DEFENDANTS.

Notice.

To the State of New Jersey and the Passaic Valley Sewerage Commissioners, Defendants:

You will please take notice that the complainants herein, The People of the State of New York, by their counsel, will move the above court on Monday,

February 5, 1917, to set a day certain for the hearing of argument upon the issues and contentions raised herein.

EGBURT E. WOODBURY,
Attorney General of the State of New York.

WILLIAM J. O'SULLIVAN,
Special Counsel, Municipal Building, City of New York.

IN THE

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1916.

No. 3, Original.

IN EQUITY.

THE PEOPLE OF THE STATE OF NEW YORK,
Complainants,

vs.

STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS, *Defendants.*

Motion on Behalf of the Complainants, The People of the State of New York, to Set a Day Certain for the Hearing of Argument Herein.

To the Honorable the Chief Justice of the United States and the Associate Justices of the Supreme Court of the United States:

Come now The People of the State of New York, by William J. O'Sullivan, their counsel, and move the court as follows:

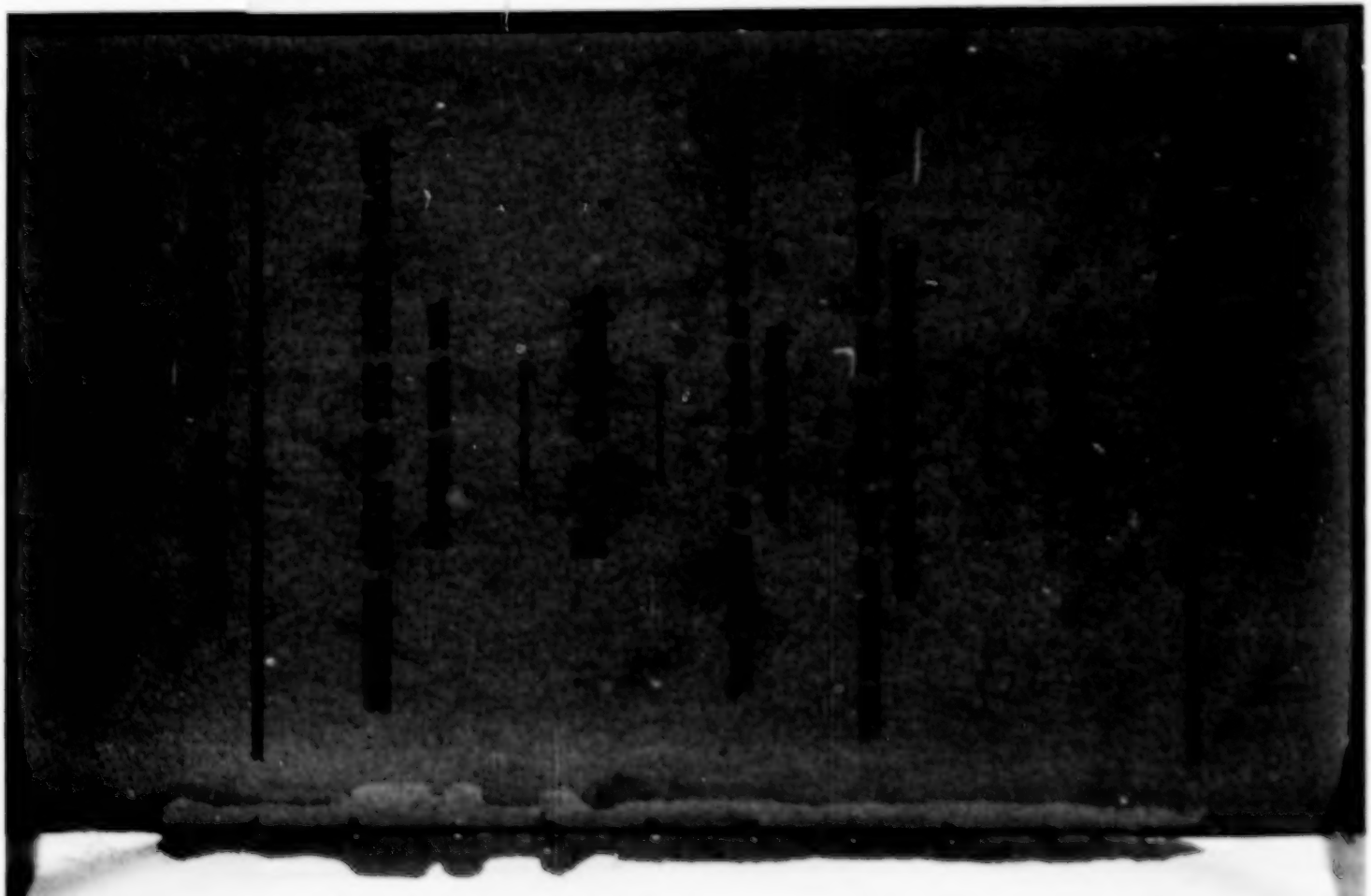
That this court cause to be set down a day certain for the presentation of the issues and contentions raised in the pleadings, and supported by the testimony and exhibits placed in evidence by the complainants and by the defendants in the extensive record of this suit now filed with the clerk of this court.

That this court order a day certain to be set for the hearing of argument by counsel for complainants and by counsel for defendants on the issues herein.

That a day certain be set down for argument herein early in the month of April, 1917, is respectfully requested and prayed for by counsel for complainants.

EGBERT E. WOODBURY,
Attorney General of the State of New York.

WILLIAM J. O'SULLIVAN,
Special Counsel, Municipal Building, City of New York.



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ADDITIONAL TESTIMONY.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1920.

No. 2, Original.

THE PEOPLE OF THE STATE OF NEW YORK, COMPLAINANTS,

vs.

THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS.

IN EQUITY.

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SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1918.

No. 3, Original.

THE PEOPLE OF THE STATE OF NEW YORK, Complainants,

vs.

THE STATE OF NEW JERSEY and PASSAIC VALLEY SEWERAGE COMMISSIONERS.

This cause came on to be heard at this Term and was argued by counsel; and it appearing that the suit was begun by bill filed October 17, 1908, that answer was filed January 24, 1909, and that the cause was put at issue by replication filed November 8, 1909; that the taking of testimony was begun on June 26, 1911, and closed on June 27, 1913, more than five years before the final argument of the cause in this court; and the court deeming it proper that additional and supplemental proofs should be taken for the following purposes:

It is ordered that the defendants may proceed with all convenient dispatch to take the testimony of not exceeding three sanitary or engineering experts, deemed by them best qualified, concerning the following subject matters:

(1) Any practicable modification of the proposed system of sewage disposal of the Passaic Valley Sewerage Commissioners, either as to construction, arrangement, or operation, and the nature and character of sanitary or engineering appliances that may be added thereto or introduced therein, in order to lessen the alleged polluting effect of the effluent upon the waters of New York Harbor.

(2) Any practicable plan of sewage disposal or treatment capable of being applied to the sewage of the City of New York and the several Boroughs thereof in order to lessen the alleged polluting effect of said sewage upon the waters of New York Harbor.

(3) Additional testimony (to the extent reasonably practicable within the time herein limited) as to the present degree of pollution of the waters of New York Harbor, including those parts affected or to be affected by the proposed Passaic Valley Sewerage system and by the sewage of the City of New York; and the change, if any, in the degree of such pollution since the time to which the testimony heretofore taken relates.

The taking of the above testimony by the defendants as stated in

paragraphs 1 and 2, including also any testimony which said defendants may choose to offer on the subject matter specified in paragraph 3, shall be concluded on or before the fifteenth day of June next.

The complainant shall thereupon be authorized to take the testimony of not exceeding three sanitary or engineering experts as specified in paragraphs 1 and 2, including such proof as they may elect to offer on the subject matter covered by paragraph 3, the testimony relating to these subjects to be concluded on or before the fifteenth day of August next.

The defendants may thereupon, if they are so advised, recall in rebuttal the sanitary or engineering experts who may have been examined by them in accordance with paragraph 1 and 2, and may also introduce rebuttal evidence relating to the subject matter of paragraph 3, all such testimony in rebuttal to be concluded on or before the fifteenth day of September next.

James D. Maher, Esq., of the District of Columbia, is hereby appointed a commissioner to take and return the above-mentioned testimony, with the powers of a master in chancery as provided in the rules of this court.

This cause is hereby restored to the docket for further argument on a day to be fixed upon the coming in of the said testimony.

March 10, 1919.

1 In the Supreme Court of the United States.

THE PEOPLE OF THE STATE OF NEW YORK, Complainants,

vs.

THE STATE OF NEW JERSEY and PASSAIC VALLEY SEWERAGE COMMISSIONERS, Defendants.

Transcript of Testimony Taken in the Above-entitled Cause before James D. Maher, Esq., Commissioner Appointed by the Supreme Court of the United States, at the Office of Riker and Riker, 164 Market Street, Newark, New Jersey, on Wednesday, June 4th, 1919, at 10 a. m.

Appearances.

For Complainants:
Charles D. Newton, Attorney General of the State of New York.
William J. O'Sullivan, Solicitor and of Counsel.
Hon. Charles E. Hughes, Special Counsel.

For Defendants:
Thomas F. McCran, Attorney General of the State of New Jersey.
Adrian Riker, Counsel, Passaic Valley Sewerage Commissioners.
Robert H. McCarter, Special Counsel.

2 It is stipulated and agreed by and between the counsel for the respective parties that the testimony may be taken stenographically and afterwards reduced to typewriting, the signing of the same being waived.

GEORGE W. FULLER, called in behalf of defendants, being duly sworn according to law, on his oath says:

Direct examination.

By Mr. Riker:

Q. Where do you live, Mr. Fuller?
A. I am living now at Summit, New Jersey.
Q. Woul- you mind stating your age?
A. I am fifty.
Q. What is your profession?
A. I am a consulting engineer, making a specialty of sanitary matters applied to municipal work, and dealing particularly with matters of water supply, water purification, sewerage and sewage disposal.

Q. How long have you been engaged in this profession?

A. About thirty years.

Q. And during that time where has been your residence for the most part?

A. For the past twenty years I have lived in the New York District; I have a house in New York City; and I have lived a
3 portion of the time in New Jersey. The greater portion of my residence here in New Jersey I have lived at Summit. I will trace the whole period?

Q. Yes.

A. I started in this line of work in 1888. While I was a student in the Massachusetts Institute of Technology, I was greatly interested in sanitary matters, which at that time received a great impetus through the work of the Massachusetts State Board of Health. At that date the State Board had recently been organized and given jurisdiction in matters of water supply and sewerage and sewage disposal in Massachusetts. I pursued my studies at the Institute, taking so far as I was able, courses which led in later years to a course in sanitary engineering. I however specialized in the early portion of my course in chemistry and graduated in that department.

I then went abroad and studied bacteriology at the Hygienic institute in the University of Berlin. I spent some time in the office as a private student in connection with sanitary matters for the city of Berlin. I visited numerous European sanitary works and returned to take the position on the technical staff of the Massachusetts State Board of Health. With that Board I spent about five
4 years largely at the Lawrence Experiment Station, where I was actively connected with tests to develop the most practical means of purifying water and sewerage. Those tests were quite exhaustive and were viewed in the light of engineering, chemical and bacteriological data.

Q. Did you make any reports on these tests?

A. Yes; those tests were reported upon fully and I was active in the preparation of many of them. Some of them I prepared myself quite completely.

In 1895 I went to Louisville, and at that city and at Cincinnati, I spent about four years in having charge of quite an extensive series of investigations as to the best means of purifying the muddy and sewage polluted water of the Ohio River for the purposes of public supply.

I came to New York City in June, 1899, and for the past twenty years I have been in private practice, making a specialty, as I have said, in sanitary engineering and work pertaining to that branch of municipal sanitation.

Q. Are you a member of engineering societies, national and local?

A. Yes, and international.

Q. Will you name some of them?

A. I am a member of the American Society of Civil En-
5 gineers, American Society of Mechanical Engineers, American Institute of Consulting Engineers, the Canadian Insti-

tute of Engineers, the British Institute of Civil Engineers, and many local organizations in this country. I am also a member of the American Chemical Society and the Society of American Bacteriologists and American Public Health Association, and others.

Q. Are you engaged, or have you been engaged in instruction in any of the institutions, colleges or universities of this country?

A. Yes, I have been a lecturer for several years in sanitary engineering at the Sheffield Scientific School of Yale University.

Q. Have you published any works or treatises or pamphlets on the subject with which you are connected?

A. Yes, I published in 1898 a volume on water purification, embodying my investigations and experiences with the Ohio River, and particularly the work which was done at Louisville, from 1895 until 1897. I also published in 1912, a book on sewage disposal. I have contributed quite a number of articles bearing upon sanitation from an engineering, chemical and bacteriological viewpoint, respectively.

Q. What connection have you had with the sewage disposal projects of various cities and towns in this country?

6 A. I have been actively connected, I presume, with one hundred or more sewage disposal projects for American cities and towns during the past twenty years and more. These engagements covered about all of the ranges of sanitary engineering work; that is to say, that they have covered reports and investigations as to existing conditions, and the best means of solving the problems with recommendations as to the most advisable works, and the cost thereof, both for construction and operation. I have prepared plans and specifications for the construction of sewerage and sewage disposal works for quite a number of communities; also, I have supervised the construction and the operation of plants, for sewage treatment.

Q. With what sewage disposal projects have you been connected?

A. Leaving out of view the various projects in Massachusetts during my period of service from 1890 to 1895, I would mention Bridgeport and Stamford, Connecticut; Buffalo and various towns and cities in the Niagara Valley, in Western New York; Erie, Pennsylvania; Cleveland, Columbus, Lima, and Toledo, Ohio; Indianapolis, Indiana; Chicago and its suburbs in Illinois; Kansas City, Missouri; Memphis, Tennessee, New Orleans, Louisiana;

6a Atlanta, Georgia; Daytona, Florida; Hampton, Virginia; Baltimore, Maryland; Norristown, Altoona, York and Reading, Pennsylvania; Philipsburg, Riverton, Atlantic City, Plainfield, New Brunswick, Elizabeth, Madison, Chatham, New Jersey; Huntington, Long Island, and numerous other places, including towns and cities in the Metropolitan District of New York.

Q. In the last three years what, if any, connection have you had with the United States Camps?

A. I was one of the sanitary sub-committee men on sanitation and engineering, under the Council of National Defense, when this country became a participant in the World War. I spent some time in 1917 in Washington in organizing and formulating general plans of procedure with respect to the new army camps which our country

built for the National Army and National Guard troops. I was active for a great portion of the period during which this country was engaged in the war, as a consultant to the construction division of the army in the matter of extensions and betterments, and particularly the operating procedures for water supply and sewage disposal projects at the various army camps in this country.

Q. What knowledge or experience have you gained or had in connection with the Chicago drainage?

7 A. I have been actively connected with that enterprise on three different occasions; first, in 1903, I investigated the sewage conditions of Chicago, and particularly its methods of disposal of its sewage by means of the Chicago drainage canal. That work I did on behalf of the State of Missouri, preparatory to testifying in the so-called Chicago Drainage Canal case before the United States Supreme Court. That work covered a period of quite a number of months, and involved a study of the purification conditions surrounding the Canal, and particularly the waters of the Illinois Valley and of the Mississippi River, into which the contents of the canal were discharged.

In 1906 I was appointed a committee in connection with my then partner, Dr. Rudolph Herring, to aid the International Committee on Deep Waterways, in formulating a procedure whereby the suburbs of Chicago might dispose of their sewage without arranging for a branch of the Chicago Drainage Canal through which it was proposed to divert more water from Lake Michigan down through the new branch proposed,—the main canal, into the Illinois and Mississippi Rivers.

In 1913 I spent a large portion of my time in the Chicago District investigating means of collecting the sewage of the entire sanitary district and treating it in works of artificial construc-

8 tion. That work was undertaken as preparation to an appearance which I made as a witness on behalf of the Chicago sanitary district in the so-called Federal suit. That suit was an injunction brought by the United States Government to restrain the Chicago Sanitary District from diverting more water from Lake Michigan through the drainage canal than was set forth in the certificates issued by the Secretary of War, during the early life of the canal, and which certificates, I believe, had not for some time been issued at all. That is really an international question and prompted by the action by the Federal Government in this country and prompted to a considerable extent by the views of the Canadian Government in opposing the diversion of Lake Michigan water.

Q. Mr. Fuller, in the district for drainage in the New York Harbor what work have you done, in your specialty?

A. I have been familiar for twenty years with water supply problems in this district. That is true of the water supplies taken from the Upper Passaic River for New Jersey cities and towns. I also have been active on water supply matters in the City of New York at various intervals from 1902 to date.

Again, with particular reference to the sewage disposal
9 phase of sanitary engineering, I was identified first in 1901 with a project which was reported upon for the betterment of the sewage conditions of the Lower Passaic River, and in that line I assisted my then partner, Mr. Rudolph Herring, who was a member of the so-called Herring, Brown and Croes Commission, which was appointed to review that whole subject in behalf of the State Sewerage Commission of New Jersey.

In 1903, I played a similar role with respect to the report made to the Passaic Valley Sewerage Commission which had then been appointed, and the work which I did was in assisting Mr. Herring.

In 1907 and 1908 the subject was again active in our office, and my firm of Herring and Fuller were the chief engineers of the Passaic Valley Sewerage Commission, at that time preparing in substantial outline the present Passaic Valley Sewerage project as it stood, while serving as a basis for the contracts made between the Passaic Valley Sewerage Commission and the various participating municipalities.

I have investigated conditions in New York Harbor from time to time, and particularly should I mention an investigation and report which I made in 1913 and 1914; for the Metropolitan Sewerage Commission of New York. That report of mine appears
10 in the printed report of the Metropolitan Commission, appearing as I recall, under the date of April 30, 1914.

Q. What knowledge have you, Mr. Fuller, of the dilution method and treatment processes associated with sewage disposal in different cities of this country and the European projects?

A. I have followed that question pretty actively in connection with a good many projects, both in this country and abroad. That is a subject which I have investigated from time to time, as the problems presented themselves, in the Boston District. That goes back to my days with the Massachusetts State Board of Health. I am familiar with the experience of Providence, at Bridgeport, Connecticut, in the New York District here, Baltimore, at Hampton, Virginia, and Daytona, Florida. I studied it at length in connection with the fresh water communities where this matter has been most active, such as at Chicago and Cleveland, Erie and Buffalo, and I am familiar with the project as it has been developed at Toronto and Oswego, New York. I have been familiar with the problem in the Philadelphia District—not for the city, however, but I have come in contact with it more particularly through my duties as consulting engineer to the water works of Chester, Pennsylvania. That city, about a dozen miles below Philadelphia,
11 derives its water supply from the Delaware, in which the Philadelphia sewage is discharged.

I, of course, have had an opportunity to study the subject elsewhere in connection with my water supply experience. I should mention the Louisville and Cincinnati experiences, where I was engaged for some four years, and later I had occasion to study it in connection with my work for some nine years as a member of

the board of Engineers at New Orleans, having to do with drainage sewerage and the new water *water* supply in that community.

In Europe I spent a good deal of time on half a dozen visits in looking into sewage disposal questions and as applied to the dilution method. I would mention London, England, and Hamburg, Germany. I am familiar also with experiences in the Rhine Valley, including Cologne, and the methods of sewage treatment in conjunction with the dilution process in the so-called Emscher Sanitary District and Frankfort and other places.

I am familiar also with sewage disposal conditions in Paris, but the dilution method had substituted for it land treatment during the years preceding my active study of conditions there.

Q. I show you, Mr. Fuller, Defendant's Exhibit No. 5 in this cause dated March 25, 1909, being a communication ad-
12 dressed to the Passaic Valley Sewerage Commissioners and purporting to be signed by Rudolph Hering, George W. Fuller and Edlow W. Harrison, and I ask you whether you are the person who signed that report?

A. I am.

Q. And do you know of your own knowledge of the signing of it by the other two whose names appear at the end of that communication?

A. Yes, I do.

Q. What recent acquaintance have you made with the Passaic Valley disposal plan and on what occasion or by reason of what did you make the investigation?

A. I was retained by counsel for the Passaic Valley Sewerage Commission in March of this year to make an investigation preparatory to stating my views with reference to the subject matter of an order of the United States Supreme Court dated March 10, 1919, in the suit here in controversy. In connection with that investigation I examined the record of the testimony in this suit and various documents and records on file in my office; I visited the engineering offices of the Passaic Valley Sewerage Commission, and was furnished with information showing the progress which had been made towards carrying out treatment works as called for by the stipulation between
the United States Government and the Passaic Sewerage Com-
13 mission as representatives of the State of New Jersey in this suit. I visited the site on Newark Meadows where the pumping station and sedimentation basins are now being built. I went to the lower portion of Bergen Point, at the City of Bayonne and saw pipes and dispersion nozzles which are being built in New York Bay to lead the sewage to the dispersion area in the vicinity of Robbins Reef light. I have made quite a number of inspections of the waters of New York Harbor. On one occasion in particular I took a boat trip generally throughout the Bay, up the Hudson River through the Harlem River, down the East River, through Buttermilk Channel to the Narrows and a portion of the Lower Bay. I have visited the area where it is proposed to disperse the treated sewage from the Passaic Valley Trunk Sewer, and I have also been to the waters coming from Kill von Kull, near Bergen Point. I have been to a num-

ber of other places, such as Gowanus Canal and have generally endeavored to make myself familiar with conditions in the Harbor as found during the past eight or ten weeks. I crossed the Hudson River on the Ferry boat repeatedly in addition to the special trips.

Q. And in those crossings have you noticed the condition of the waters?

14 A. Yes, I have paid special attention to the appearance of the waters of the Harbor.

Q. Are you familiar with the order of the Supreme Court entered on March 10, 1919?

A. Yes, sir.

Q. Mr. Fuller, from your examination of the matters that you have testified to, and particularly the works as they are being constructed, do or do they not embody the terms of the stipulation between the United States and the State of New Jersey and the Passaic Valley Sewerage Commissioners?

Mr. O'Sullivan: I object to that question on the grounds that the plans and specifications that are indicated to carry out the stipulation are not now on record, nor have they been at any time on record, and this witness so far has not indicated that he — familiar with these plans and specifications, and I think that your hypothetical form of question is inadmissible.

Commissioner Maher: Note the objection of counsel for the complainant.

A. They do.

Q. And are those plans and specifications the plans and specifications to which you had reference in that communication to the Passaic Valley Sewerage Commissioners, which is marked Defendant's Exhibit No. 5?

15

Mr. O'Sullivan: I object to that question on the ground that there were no plans and specifications in esse at the time that defendant's Exhibit 5 was signed by this witness; and on the further ground that there is no evidence so far in this case of what the actual plans and specifications of the Passaic Valley Sewerage Commissions are in order to carry out these stipulations.

Commissioner Maher: Note the objection of counsel for the complainant.

A. They are.

Mr. O'Sullivan: I now make a motion to strike out this answer until such time as the plans and specifications are produced and put on record in this case.

Commissioner Maher: Note the motion of counsel for complainant.

Q. What are the elements of the proposed Passaic Valley Sewer and Works as they are projected and shown by the plans and specifications and as you saw them in course of actual construction?

Mr. O'Sullivan: Objected to on the ground that the plans and specifications are not in evidence nor have they been at any
16 stage of these proceedings produced, and my objection goes until such time as they are produced.

Commissioner Maher: Note the objection of counsel for the complainant.

A. Those works which I find in process of construction embody screens, sedimentation basins and dispersion facilities, particularly do I refer now to the nozzles attached to the pipes laid in the bottom of the Bay for the dispersion of the sewage at the dispersion area near Robbins Reef light.

Mr. Sullivan: I move that that answer be stricken out as there is no evidence in this proceeding of what these nozzles and dispersion devices are, nor are there any plans before the Commissioner nor have any been produced at any stage of these proceedings, relative to the screens, or sedimentation basins, or other details relating to screens, or the sedimentation basins.

Commissioner Maher: Note the motion of counsel for complainant.

A. I was intending to proceed and state the structures as I actually found them on the occasion of my visit, long prior to this year, to the various works of the Passaic Valley Sewerage Commission.

In regard to the sedimentation basins, I found that there
17 were in process of construction some concrete basins or tanks. They are arranged in four sets. They have no cover, that is, the top is exposed to the air. The top walls are about 25 feet above ground level, and they are built with a hopper bottom; each of those four sets has three sections or bays, and in each bay there are nine of these large hoppers. The present installation as now under construction is intended to serve about one-half of the total capacity of the trunk sewer, that is one-half of the total ultimate capacity of the sewer, which is in round numbers 360,000,000 gallons in twenty-four hours. I found the capacity of these tanks as shown by the plans and my inspection to be about 9,000,000 gallons; that would provide a detention period of 108 minutes, on an average when pumping at the rate of 120,000,000 gallons daily. This period would be seventy-two minutes, when the rate of pumping is 180,000,000 gallons daily.

I found the inside length of basins to be about 216 feet with two intermediate baffles making each compartment, roughly, 72 feet long. I computed the velocities with a pumpage of 120,000,000 gallons daily to be on an average of about four-tenths of an inch per second, or 120 feet per hour. At 180,000,000 gallons, rate for 24
18 hours, the velocity would be 50% greater than those which I have just stated.

I found the sedimentation basins actually being built to be in conformity with the stipulation of the United States Government for the volume of sewage which will be expected for some years to come.

I also found that it was projected to build more basins as the need thereof arises in the future.

In regard to the screens, I found that the screens as actually built consist of cage screens, such as generally are used at the Boston sewage disposal plants. They consist of iron bars placed so as to give a direct passage as one looks through the screens, a space of about one-eight- of an inch. These rods are placed in the cage in a staggered fashion, with the actual distance diagonally from bar to bar of about three-quarters of an inch. These screens are cleaned by lifting one cage at a time and thus removing the materials which are attached to the screen bars and to the receiving basket or receptacle at the bottom. These screens are hand cleaned screens and not screens of the revolving type. That is not a literal compliance with the provisions of the stipulation, but it is my opinion that it would produce an equal amount of clarification.

As regards the removal of the coarser matters in this sew-
19 age. I found that opinion also stated in the certificates of approval issued to the Passaic Valley Sewerage Commission by the Department of War at the time when they received their permit for constructing these works.

At the dispersion area I found that they were building outlet pipes to which were attached nozzles of unusual interest to me. These nozzles are placed vertically in openings in the concrete pipes through which the sewage is dispersed. There are 150 of these nozzles, and the point that I was particularly impressed with is the fact that these nozzles show a vane in the interior which is eccentrically placed and leaves at the periphery an angular space about two inches wide, and by means of this partition of vane in an oblique position there will be released from these nozzles the sewage, in the form of a thin ribbon, which possesses a swirling movement.

Q. How will that be discharged, Mr. Fuller, vertically, horizontally or in what way?

A. It will be discharged vertically; the sewage will pass vertically through these dispersion nozzles in the form of a thin ribbon, and given a swirling movement.

Q. You saw this in actual course of construction or some of them actually finished, did you?

A. I saw the nozzles on the shore ready to be moved to the
20 dispersion area, and when I went to the dispersion area I saw men at work. I cannot say I actually saw them in place on the bottom of the Bay, but this is the program shown by the plans which my inspection showed to me was being actually carried out.

Q. You have testified as to the situation on the Meadows and the dispersion area. There is also, is there not, a collecting system for the works; I mean by that, the gathering sewers?

A. Yes, the trunk sewer, collecting sewer. I made no special study of that, but have seen it from time to time for a number of years in process of construction from Paterson down the valley in vicinity of the river's edge or thereabouts on down to the pumping station on the Meadows where the sewage first passes through screens and grit chamber. This is pumped to the sedimentation basins

which I have described. Then the sewage from this elevated position above the ground surface will flow by gravity through a tunnel built under Newark Bay, across Bergen Point, and out under New York Harbor to the dispersion area in the vicinity of Robbins Reef light.

Q. Do you know anything about the grades of the trunk sewer and branches?

A. I looked into that a number of weeks ago with a view
21 to saying as to whether they were capable of producing what I call a scouring velocity. I found the grades reasonable, having that feature in view.

Q. What is the importance of that feature, Mr. Fuller?

A. It is of importance with respect to *to* getting the sewage delivered to a pumping station at the outlet of your trunk sewer. That is not handicapped by the odors arising from the putrification of stranded solids. And I might also say that I have given attention further to the question of velocities in the sewers which would lead to this marginal or trunk sewer along the Passaic River, having in mind this particular point of stranding of solids.

Q. And what have you determined upon that examination?

A. Generally speaking, I found that the grades of sewers leading to the trunk sewer are pretty satisfactory as regards the freedom from what I call depositing velocity, that is, low velocities and flat grades, west of the Pennsylvania Railroad tracks here in Newark. I don't mean that every sewer has a grade preventing the stranding of solids, but generally speaking, above the Pennsylvania Railroad tracks here in the City of Newark, there are slopes to the land surface such as will readily provide good velocities, and the velocities in the case of sewers which I have noted will behave satisfactorily in that respect.

East of the Pennsylvania Railroad tracks here in Newark the
22 ground is, of course, flatter and it is a fact that there are some grades which are flat, and that means, to my thought, that there should be careful attention to preventing the accumulation of these sewage solids to remain in for too long a period, in dry hot weather, without flushing. That is to say, I have looked at this Passaic Valley Sewerage enterprise in the light of whether careful operation would allow those having it in charge to eliminate the stranded solids which have a tendency to putrefy at times and give off offensive products to the sewage which flows over such stranded solids.

Q. To what particular feature of the stipulation between the United States and the State of New Jersey and Passaic Valley Sewerage Commissioners does this matter of offensive odors relate? I refer now to Complainant's Exhibit No. 135, which I hand you.

A. I will have *you* to look at it and see the number. It refers to the amount of odors—that bears on paragraph 3 with respect to odors in the vicinity of the dispersion area in New York Bay; also paragraph 5, with respect to the nuisance question, and also to paragraph 7, in reference to the dissolved oxygen contents of the waters in New York, resulting from the discharge of Passaic Valley sewage. I am

referring to numbered paragraphs which appear in the second
23 section of this exhibit in question, being the numbered stipulations in the exhibit in question.

Q. Have you attempted to determine the result of the treatment which will be given to the sewage at the works on the Meadows?

A. Yes, sir.

Q. Have you made a determination?

A. I made an investigation and have studied the matter. Of course the works are not in service. I have not made a determination in the sense of trying to record performances.

Q. You made an estimate?.

A. Yes, sir, I formed an opinion and estimate.

Q. What is that estimate?

A. In my opinion the works as being built will give a performance substantially in conformity to that called for by the stipulation.

Q. Can you give that in any other form; as to the amount of removal of solids from the sewage, for example?

A. The total suspended matter in the sewage I should say would be removed to the extent of fifty to sixty per cent on an average. The removal of total of organic matter from the sewage would be from twenty-five to thirty per cent.

24 Q. Do you know what population is provided for by the contemplated works of the Passaic Valley Sewerage Commissioners?

A. It is provided that there will be ultimately a sewage of about 1,700,000 people disposed of by these works.

Q. Now, Mr. Fuller, will you refer to the order of the Supreme Court of March 10, the first section of it, and tell us in what ways the works can be added to or altered by the addition of arrangements or any operation, in order to lessen the probable alleged pollution effect of the effluent upon the waters in New York Harbor?

A. In the first place, with respect to the basins, I am of the opinion that there will be at times a greater removal of total suspended matter and of organic matter, if the velocity of flow were somewhat less than set forth in the stipulation and less than those velocities which I have already stated in my examination this morning as resulting from the basins as built. That means that betterments could be obtained either by modifying the existing basins or by building more basins, or by taking first one and then the other of these two suggestions, at such time as the need therefor in the future should be demonstrated.

The question of building more basins I do not think is a factor
25 which need be considered for a long time to come. The modification of the present basins could be brought about without very serious change in structures now building, and by this I mean to say that there could be changed the length of travel set forth in the stipulation,—instead of having the sewage moved some 216 feet at the velocities given it would be helpful in my opinion to arrange the inlet and outlet connections to the basins so that the sewage would actually travel only about 72 feet. That would make the velocities one-third of what they would be as set forth in the stipulation, or as actually found with the basins now being built for given

volumes of sewage treated. I think under those circumstances, taking the sewage for one-third of the distance of travel at also one-third the velocity, there would then be no opportunity for doubt as to removing say sixty per cent of total suspended matters and about thirty per cent of the total organic matter as the record day in and day out. I am aware that it is not desirable to prolong the period of sedimentation needlessly on account of the tendency which is found for the dissolved oxygen to lessen. Hence I do not favor considering building larger basins immediately. I am firmly of the opinion that they would not be required for some years to come. In regard to

26 these sedimentation basins, I should make it plain that they will contain scum boards or baffles extending beneath the surface of the liquid, in order to retain scum, floating matters, grease and the like. I also ought to mention one other fact, and that is that these tanks are a distinct improvement over the old-fashioned so-called flat-bottomed tank. These tanks are built with pockets or hoppers at the bottom into which the sludge will pass. These hoppers have sloping sides; the slope is about 52 degrees from the horizontal, and arrangements are made for this sludge to be removed by piping with the aid of compressed air if necessary and be delivered to barges for transportation to the ocean. These hoppers containing the sludge in the location that is actually found, guards against the stirring up of the sludge found on flat bottomed tanks and is a decided improvement over the tanks as built more generally up to within quite a recent period.

Q. Will the modification you suggest to the tanks that are now constructed or in course of construction be a very expensive matter?

A. No, those changes, I should estimate, could be installed for the complete set of units now in process of erection for a sum ranging from $100,000 to $150,000.

27 Q. In Exhibit No. 5, to which your attention has been drawn, you I think, expressed an opinion and made a survey to the Passaic Valley Sewerage Commissioners as to the results of the treatment and dispersion of the sewage under the details therein contained. Now, with the addition of the modifications which you have testified to, will it or will it not be more certain that the results will be obtained?

A. I think it would be more certain.

Q. Have you any doubt as to the obtained results from the stipulated processes that are now being put into the actual plant?

A. None whatever.

Q. Are there any further or other modifications of the plans which will assist and render the result even more certain, Mr. Fuller?

A. Yes, the treatment of the sewage in the tanks might, if it should be found necessary, be supplemented by the installation of very fine screens or strainers placed in the effluent water ways through which the sewage would pass from the tanks to the tunnel leading to New York Bay.

Under all ordinary circumstances I believe that scum boards

would retain the floating matter, but it is a fact that tanks
28 with ordinary operating schedules for cleansing, sometimes show in very hot weather a tendency for the sludge to be lifted by gas—by sludge, I mean the solid from the sewage which would deposit in these hoppers that I have described, at the bottom of the sedimentation tanks. I believe it would be not only perfectly feasible, but desirable to have an operating staff of such numbers and such efficiency to remove the sludge during warm weather, so as to guard against that; but it is practicable, if need be, to install very fine screens to guard against the passage into New York Bay of gas lifted particles of sludge from the bottom of the sedimentation basins. In other words, the fine screens would be guarding against the accidental or abnormal phase of tank performance, and not the normal or regular performance.

Q. Are there any further or other modifications, either of construction or treatment, which will make more certain the guaranteed results from the stipulation which is Complainant's Exhibit 135?

A. Yes, I have considered the question of guarding against the putrefactive condition which might arise during very hot weather in the sewage as it reaches the pumping station and sedimen-
29 tation basins on the Newark Meadows. In addition to the question of guarding carefully against permitting stranded solids to accumulate in the sewers, I am of the opinion that aid might also be secured by blowing air into the sewage at one or more points along its line of travel from Paterson to the pumping station on the Newark Meadows. By blowing in air, I do not mean to imply that I am speaking of the oxidization, but the delivery of air into the sewage to aid as a preservative; that is, to prevent putrefactive processes being established. In pursuance of this thought, I have made a study of blowing air through a perforated pipe system installed within the trunk sewer itself below the Paterson city limits, and thus tending to prevent the sewage becoming stale or as it is sometimes spoken of, septic. This treatment would not be an expensive one to install. I estimated that an electrically driven blower might be installed with pipes at or near the city line at a cost of say $30,000 in round numbers. It would also be possible to aerate the sewage again at the basins on Newark Meadows, and as the years go by and if occasion arises, aeration could be installed also at intermediate points, perhaps below Passaic and in the northern limits of the city of Newark. I do not contemplate that such inter-
30 mediate aeration would be required for a long number of years. What I meant to say was, the use of air for preserving the sewage against putrefaction could be utilized in a practical way to such an extent as actual experience found necessary, as the years go by.

One other feature I should mention for better operating conditions, and that is the variation in the rate of pumping sewage from the trunk sewer into the basins from whence it will flow by gravity to New York Harbor. If at certain intervals during the day the sewage was pumped at say one-half the ordinary rate of speed, and at other intervals correspondingly greater increase above the normal, two

things could be accomplished. In the first place, the use of a high rate of pumping could be availed of to promote higher velocities, if it were necessary to resort to that arrangement, for eliminating the stranding of solids above the pumping station. In the second place, the velocities of flow of harbor water at the dispersion area at the vicinity of the hour when the tide turns is less than it is on an average. When the velocity is abnormally low, for half an hour each way of the turn of the tide, it would be feasible to lessen the
31 delivery of sewage, say cut it down to fifty per cent or even less of the normal; that would tend to aid in lessening the volume of sewage meeting the less quantity of diluting water. In speaking of these volumes and of these velocities, I wish to point out here the fact that the tide does not come to a standstill and turn at the same hour at the top and bottom depths of the dispersion area; that the mean velocity of a full vertical depth of water over the dispersion area is found to average not less than three inches per second, although it is a fact that there may be places where the velocity is less than this; so that with partial retention of the sewage in the basins and in the trunk sewer as found most convenient in operating a pumping station at varying rates, would serve these two purposes, and they would be beneficial to the end sought in the stipulation.

I might proceed also with the last point which I have considered in this program of betterment procedures, and that is to refer to the fact that if any extraordinary condition should arise during a very hot season, it would be possible to increase the removal of total suspended matters and of organic matter from the sewage passing though these basins by resorting to the use of chemicals. By
32 that, I mean to say, that lime and sulphate of alumina or sulphate of iron might be added to the sewage as it enters these basins. That chemical treatment would promote the classification in conjunction with the sedimentation resulting from the flow of the sewage through the basins, and in my judgment would bring the removal of total suspended matters from about sixty to eighty-five per cent, and of the total organic matter from about thirty to fifty per cent.

Q. Are those figures based upon experience, Mr. Fuller?

A. Yes, sir, chemical precipitation is a process that was in vogue quite generally in England and has been used in this country at Worcester, Massachusetts and Providence, Rhode Island, although it has not been resorted to regularly at Providence in recent years.

Q. You have been testifying to modifications either in construction or operation at the treatment works. On the most part, you have testified as to the introduction of air in the power lines. Is there any other modification or devices in the way of operation, which is applicable to the collecting system of sewers, where the grades are flat?

A. Yes, I have spoken already at some length of the desirability of removing stranded solids, and to do that, a number of
33 things can be done, according to what is most convenient for the particular sewer in question. Flushing with water is

efficient for dislodging these st-anded solids, which putrefy and give off objectionable odoriferous products, and that is actually secured in those combined sewers when the storms come. In fact, it is the channel through which the storm water is actually moved. It is feasible to apply a hose from hydrants from the water system and then discharge through the manholes to dislodge these solids. Another method which I have used in a number of cases with success is to install what I call a flushing gate. By that I mean the placing in a manhole of a gate with a lever that can be operated conveniently by reaching down into the manhole. By closing this gate the flow of sewage is dammed up and there is accumulated a considerable head, depending upon local conditions. Then upon pulling the lever and opening this valve quickly, there is established a scouring velocity which I found very helpful in quite a number of places in keeping the sewer quite free from stranded solids. I have also in a number of cases during hot weather periods diverted water from small brooks in the vicinity, through lines connected with the sewers, with the distinct purpose of maintaining velocities which would prevent this stranding of solids. I should make plain,
34 however, that these stranded solids are more likely to occur in the sparsely populated districts, where the flow of sewage is relatively small, than in the well built up area where the sewers are of relatively large size and have the faculty of allowing a sufficient slope to be created within them so as to bring about a scouring velocity.

Q. Now, with reference, Mr. Fuller, to the outfall and dispersion features of the system, have you any modifications to suggest as to them?

A. No, I have not, because I believe that these dispersion nozzles are the best that have ever been designed for any project.

Q. Can there be, in your opinion, any change made in the depth at which it is discharged which would be advantageous?

A. That depth is fixed now by the elevation of the bottom of the harbor to the flow lines. I think that that is not capable of change within the limits of the dispersion area in question. I suppose that more nozzles might be located in the deeper portions of the area. I do not believe, however, it is at all necessary, because I am convinced that there will be no doubt about the sewage being broken up before it reaches the surface of the harbor water. In other words,
35 I do not believe there is any need at all of considering any betterments at the dispersion nozzles, because I do not believe there will be any likelihood whatever of a pool of sewage appearing at the surface.

Q. I think you have said that the works as now being constructed, so far as the danger is concerned, are sufficient to take care of 1,250,000 gallons a day. Am I right in that, or is that the fact?

A. They would take care of 180,000,000 gallons for twenty-four hours. I think the figure you have spoken of is the capacity of some portion of the contents of the tanks.

Q. What is the population that that is reasonably to be expected to be produced by?

A. That figure corresponds to a volume of sewage flow one half of the ultimate capacity of the sewer, and that would mean that one half of the total population in round numbers 1,700,000 people or about 850,000 people. I should make plain that I am speaking now of the maximum flows, whereas the dry weather flows would be roughly two-thirds of that. I have formed a view that there would be in the early future sewage amounting to about 120,000,000 gallons daily in dry weather. That would correspond to the flow from a population of 800,000 people, in round numbers.

36 Q. I observe, Mr. Fuller, that in all of those modifications and construction and operation you are not counting upon the removal of the total amount of solids and organic matter, is that correct?

A. Yes; it is not possible to remove all of them.

Q. Taking the plans and specifications as you understand them to be as involved in the stipulation, which is complainant's exhibit No. 135, and assuming the discharge of 360,000,000 gallons of effluent at Robbins Reef per day, can you give any estimate as to the call upon the dissolved oxygen of the waters of the New York Bay that that discharge would result in?

A. That means as being actually built without the modifications that I have spoken of?

Q. Yes.

A. That can be approximated to the relation which the population attached to the Passaic Valley Sewer System would bear to the total population which would have its sewage disposed of satisfactorily in the waters of the Upper Bay. It is a matter which cannot be formulated in very precise terms, but I am of the opinion that it would not make any radical lessening of the oxygen from the standpoint of nuisance from any angle as found either at the Robbins Reef dispersion area or elsewhere in the harbor for many

37 years to come, so far as that factor alone is concerned. I am aware of the fact that the most perfectly clarified sewage would make some demand, however, upon the dissolved oxygen content of the harbor, but it is my judgment that the margin is so great that it would not be a matter of great significance for many years to come.

Q. You are not willing, then, I take it, are you, to put the call in any percentage of the oxygen in the water?

A. I have not endeavored to do so. I think that I could formulate some range of percentages which would vary with different seasons of the year, but it would depend upon a variety of other facts. I have looked at it in the sense of it not bringing about a depletion of oxygen in the vicinity of this dispersion area sufficient to be objectionable from any viewpoint, in my opinion.

Q. What is the limit of reduction of dissolved oxygen in the salt waters of bays which is accepted as safe?

A. Viewpoints vary widely on that. The degree of safety, I assume you have in mind now the question of nuisance, and not any question of bacterial pollution. If you have some dissolved oxygen at all times in every portion of a body of water, there will not be any

nuisance arise from putrefaction. In practice, however, it is necessary to bear in mind several things. It is wise to provide a
38 margin to take into account the irregularity in mixing of the sewage with water, and it is also necessary to bear in mind that sludge accumulations produce other complications, by sludge I mean the accumulation of sewage solids on the floor of the bay for months, and perhaps years at a time, and thus produce a lessening of dissolved oxygen, which would be true even if distilled water were to pass along through the sewers into the bay. Speaking broadly, I found repeated instances where percentages of less than twenty percent of dissolved oxygen content were attended by no putrefactive odors or objectionable conditions, as regards appearance of water.

Q. Can you name some of these?

A. I will name London, England, as the most conspicuous case. I know that at Philadelphia opposite the city, in the Delaware River, there had been found dissolved oxygen content of frequently less than thirty, actually less than twenty percent.

I am aware of other places where they have low oxygen content of twenty or less, and quite frequently less than thirty. These periods of low oxygen content of course refer to the warmer
39 seasons of the year, when the temperature of the water does not allow nature's refrigeration process to check the activity of bacteriological decomposition.

In the Maumee River opposite Toledo the oxygen content becomes less than thirty and occasionally less than twenty per cent. There is no sign of appearance in the water which is unattractive, except at the edge of the stream where sewers discharge their content, and it is a fact that there are other sewage solids which are stranded and decompose and are stirred up by boats to an objectionable degree. Broadly speaking, I have taken twenty to thirty per cent as the reasonable limit towards which you could reduce the dissolved oxygen by the entrance of sewage into a stream of tidal estuary, but I am obliged to qualify that in the sense of stipulating that there shall be removed these coarse solid matters of sewage origin which if allowed to accumulate in too great quantities become objectionable. These solids, of course, would be removed very completely in the instance of the Passaic Valley Trunk Sewer Project, and if a similar removal cared for all of the sewage entering the streams at London, Philadelphia, Toledo and other places, I am positive that the
40 viewpoint as to the safe residual of dissolved oxygen would be materially different from that which is found in the minds of those who have made a study of this subject, in regard to fish life. The season of the year is a factor to be considered in that regard, and also the kind of fish and the area of the water way in which the oxygen is depleted. Now, as a practical proposition, the season of the year when fish run actively in many water ways is during the months when the oxygen is not depleted to the extent which I have indicated for the summer months. Another point is that fish can pass through waters in which the oxygen content is reduced to fifty per cent or even thirty per cent, provided they can get into other

areas where the oxygen is greater than this thirty per cent or thereabouts.

Q. Have you formed any estimate, Mr. Fuller, of the population which can be successfully cared for in the matter of sewage disposal by the waters of New York Bay?

A. Yes, I have studied that with considerable care, both with regard to discharge of sewage with very slight clarification of sewage which has been substantially freed of these settling solids, and particularly have I considered it in the light of dispersing the sewage in a manner to allow the sewage to come in contact with the dis-
41 solved oxygen of the fresh water entering the harbor.

Q. What is your conclusion in that matter?

A. I conclude that from fifteen to twenty millions of people can with safety discharge sewage into New York Bay, this range of figures being given on account of the variation in the load factor which arises from dispersion which is afforded for the sewage in the Bay and to the removal of the settling solids of sewage origin, both in the sewage as is dispersed in the water and also with reference to accumulations that may exist there now as the result of earlier discharge of raw sewage into the Bay.

Q. When you speak of New York Bay, do you mean the Lower or Upper Bay?

A. I mean the Narrows and above; I do not mean the Lower Bay or the Ocean Gateway.

Q. Do you know what the population now contributing sewage to Upper New York Bay as defined by you may be?

A. In round figures I do; I have not made a special study of it. I should place it at from between six and seven millions of people.

Q. And how many of that number are included in the communities on the shore of New Jersey?

A. Between 350,000 and 400,000.

42 Q. Have you made any special recent inspection of the conditions of the waters of Upper New York Bay?

A. Yes.

Q. When did you make it and how did you make it?

A. I have crossed the lower Hudson on the Lackawanna Ferry several dozen times during the past ten weeks, specifically, I mean, from the Terminal of the Lackawanna Railroad in Hoboken, to Barclay Street Ferry. I crossed the East River on one or two occasions. I think it was the third of May, that I took a trip that I have spoken of going generally around the waters of the Upper Bay and along the lower Hudson as far as Spuyten-Duyvel; thence through the Harlem down through the East River down to the Narrows and some distance below the Narrows into the waters adjacent to Gravesend Bay and Sea Gate. I made one trip, I think on the sixteenth of May on a boat, to examine especially the conditions of the Upper Bay, and more particularly on the Brooklyn side. At that time I went into the Gowanus Canal nearly to its upper limits. On May third I went around the Jersey side of the Upper Bay in the vicinity of Robbins Reef light and down towards Constable Point near Bergen Neck.

Q. Had you made prior observation of the conditions of the water of the New York Bay to the ones which you have now
43 testified to?

A. Yes, I made an investigation in the summer and fall of 1913, for the Metropolitan Sewerage Commission, and I have generally been on the waters of the Bay at frequent intervals. I have lived either near Riverside Drive or in New Jersey, where I used the ferries to a considerable extent for a period of some twenty years.

Q. Will you compare the conditions as you have observed them since the beginning of the month of March with the earlier observations that you have made?

A. The conditions have not changed materially during the last few years. By that I mean more particularly to say that the variations from time to time now are more marked than my notes and recollections would suggest for a change, say, for a five year interval. It is a fact that now, as formerly, there are bands of litter or rubbish causing streaks to appear where currents neutralize themselves, and such has been the case for a good many years. There is some oil and sleek on the waters of the harbor, this varies in different sections of the harbor; its appearance varies with wind conditions. There is particularly an oily appearance, apparently from gas house waste in the Gowanus Canal section, some oily sleek is noticeable in the Hudson River from time to time, although it is not universally
44 present there. The same is true of the oily appearance found in the portion of the Upper Bay adjacent to Bayonne. In the vicinity of the slips there is now, as there has been for years, signs of sewage accumulations. That is not so noticeable by any means, during the spring months as is the case during the summer. There are two reasons for that. In the first place, the sewage sludge during the spring does not putrefy to the extent that it is found in the summer months with its warmer temperatures, and when this natural refrigeration process is not available. In the second place, during the past eight or ten weeks the flow of upland water from the Hudson river has been greater and its turbidity and color has been such as to entirely eliminate the opportunity to note the finer sewage solids, although some people undoubtedly mistake this clay and vegetable stain for sewage matter. That is not true, during the spring months at least. Of course, I have not had an opportunity to compare the summer conditions of the current year with summer conditions of earlier seasons, but broadly speaking, I do not find any substantial departure from the conditions during the spring months as I have noted them in earlier years during corresponding months.

Q. Has there been any change in the odors that are per-
45 ceptible in the waters of the New York Bay during the period that you are testifying to?

A. The ordinary occupant of a boat will not notice any odors in the main channel now or in earlier years. It is possible to detect some odors if you go to the Gowanus Canal or some of these very highly polluted arms of the Harbor, but out in the main channels I have noticed no odors due to sewage, and I think that if the sample of water were actually heated in the laboratory, the

odor would be clearly an oily odor rather than that of a sewage nature.

Q. You distinguish between the oily conditions in the waters and sewage pollution?

A. Yes, I do, because the oily products, particularly those coming from gas house wastes, are very penetrating indeed, and they are more penetrating than any sewage odor. The odor from sewage arises from the foul products resulting from putrefaction in the absence of oxygen. These conditions do not obtain in the main water ways as I have found the New York Harbor in recent years, and conspicuously is this a fact during the past ten weeks.

Q. Have you observed since the beginning of March conditions of nuisance perceptible by sight or smell, existing at any
46 points in the Upper Bay which did not exist in your earlier experience with the waters of New York Bay?

A. No, I found none.

Q. Are there any places where such conditions appear to exist at the present time?

A. No, I think there are not in the main channels. I want to make plain that I must exempt these places like Gowanus Canal and Wallabout Channel and Newtown Creek. I have seen the Harlem River objectionably polluted, with its black appearance, that I felt pretty sure was showing the effect of sewage entering it in the summer. I have seen signs of sewage in the Lower East River, and I should make it plain that in this litter or rubbish which I have spoken about, it is possible to see pieces of feces and matters of obvious sewage origin. That has been true for a great many years in the waters of New York Harbor, and I don't see any change in that respect that is readily noticeable to the eye of the ordinary person using the river craft.

Q. Can you state any precaution for the protection of the waters of New York Bay that should in your opinion be taken?

A. You mean now independently of a broad sewage treat-
47 ment program?

Q. Yes.

A. Yes, I believe that these offensive sewage solids should be removed. I believe that on all boats there ought to be notices posted and effective steps taken to prevent the discharge of garbage and rubbish and oily waste. I believe that so long as crude sewage is discharged into the river there should be a systematic program adopted of what you might call river cleaning, as distinguished from street cleaning; that such a procedure is practical and I believe advisable. I believe it is objectionable to see these sewage solids in the river, brought as they are into streaks or bands where currents neutralize each other.

Q. Have you yourself made any determinations of the oxygen content of the waters of the New York Bay recently?

A. I have not personally made them, no.

Q. So that as the result of your own determination you don't know what the oxygen content of New York Bay is, do you?

A. No, I do not.

Q. I don't remember having asked you with reference to the treatment, of any, which you think would be necessary for
48 the sewage from a population of fifteen to twenty million inhabitants, which I think you testified could be safely disposed of by the waters of the Bay. Did you have in mind in that testimony any specific treatment?

A. I assumed that the accumulation of sewage sludge found around the piers would be removed by dredging, and in that way the dissolved oxygen content during the hot weather of each year would be obliged to have a portion diverted for the decomposition of sludge of preceding winter and spring months, or even of the months of earlier years. In the second place, I assumed that the sewage would be mixed with the oxygen containing waters at least to an extent sufficient to eliminate the putrefactive condition which actually — so found in some places—some arms of the Harbor at present—and would undoubtedly be found at other branches of the Harbor, prior to the time when the pollution will have reached such figures as I have spoken of. I spoke of a range of figures, also having in mind that the removal of settling solids would be desirable and should sooner or later be taken care of generally throughout the Harbor in a manner more or less corresponding to the procedures and the results thereof as reflected by the
49 Passaic Valley program. I am not trying now to differentiate in very precise figures as between a removal of objectionable sewage and the complete clarification. I am firmly of the opinion that the sewage treatment in different sections of the Harbor would very likely vary, depending upon the individuality of the local conditions.

Q. Have you made any study, Mr. Fuller, of the treatment of the sewage of New York?

A. Yes, I have spent considerable time some five or six years ago along the line of what should be the treatment for a minimum of all the sewage, practically; that is, the removal of the coarse solids by what you might call fine screening. Then I also studied first the need and then the economy of diverting a substantial portion of the sewage from the lower East River District to an island outlet in the ocean, and in that connection I studied the sedimentation of sewage as an alternate to diverting it to the ocean outlet. I have looked generally over the sewage disposal projects for that portion of the city of Greater New York which is tributary to New York Harbor.

Q. Are there processes which are practicable for the treatment of the sewage of New York which is discharged into the Up-
50 per New York Bay?

A. Yes.

Q. Is it practicable to apply to that sewage an equivalent treatment to that provided by the Passaic Valley Sewerage plans?

A. It is for a substantial portion of it. There are places where tanks would be very expensive to install, but generally speaking,

fine screens or tanks for sedimentation purposes, or the two combined, could be installed for the City of New York.

Q. And with what result so far as the suspended solid matters and the organic matters in the sewerage are concerned?

A. Well, that depends upon whether you use screens or sedimentation tanks, and with the latter what the period of sedimentation is. Screens with moderately fresh sewage, will remove about fifteen to thirty per cent of the total suspended matters, and tanks will remove up to sixty per cent, with the velocities and sedimentation period approximating those which I have described for the Passaic Valley project. Of course smaller tanks and higher velocities would result in intermediate removals of total suspended matter.

As regards removal of organic matter, generally speaking that percentage is about one and one-half the removal of total
51 suspended matter.

Q. With reference to the points of discharge of the sewage of New York into the waters of the Upper Bay, are you acquainted with the method of discharge now in practice in New York?

A. Yes, I am.

Q. What is that?

A. It is a discharge of sewers as originally built, practically at the bulkhead line, and during the past thirty years there has been a progressive extension with wooden barrel sewers out from the bulkhead to the pier head line. Those are generally submerged—I am speaking more particularly with reference to Manhattan now—but there is not an extension of sewers beyond the pier head line, and as one gets from the built-up portion of Manhattan around to its upper limits, around from Harlem River along around Brooklyn and its various water-courses, here one sees the sewers discharging, sometimes above the water line and spilling sewage at the water edge.

Q. Is there any improvement that you could name in respect to the method of discharging the sewage of New York into the Bay?

A. Yes, I think that generally speaking sewage that has been through tanks or screens in New York should be led into
52 deep water. By that I have in mind that ordinarily it would be advantageous to lead the sewers out 100 feet or so, where there would be a substantial depth of water.

Now, I also carry in mind that, however, some places, like the Lower East River, where the population is high, with respect to the volume of oxygen containing waters near at hand, that it would be advantageous to install intercepting sewers along the water's edge more or less after the fashion that has been done here in the Lower Passaic Valley, and to lead the sewage where after clarification it could be dispersed in not only relatively deep water, but water which is ample in volume for dilution without seriously overtaxing the dissolved oxygen content in hot weather. Let me repeat again, I as-

sume that the existing sludge deposit should be removed from slips and grossly populated water-ways.

Q. Have you any figures as to the actual increase in population of New York contributing sewage to the Upper Bay?

A. I have made an estimate, yes. I have estimated that there would be about 150,000 people added each year from New York City to the population discharging sewage into New York Bay.

Q. Upon what was that estimate based?

53 A. It is based from the recollections which I have made following an inspection of the increase in population of the city as a whole, which is from three to three and one-half per cent per year.

The thing that I haven't precisely in mind at the moment is what portion of the greater area is tributary to Jamaica Bay and water ways other than New York Harbor. I looked into that some weeks ago, and in round figures I placed the annual increment of population in New York City tributary to the Harbor at 150,000.

Q. I think you have said already, or will you repeat now the population which will be served by the works as now in course of construction of the Passaic Valley Sewerage Commissioners?

A. They will serve approximately one-half of the ultimate, which is 1,700,000. It is roughly 850,000 people. That is somewhat in excess of the total population of all the communities in this district.

Q. By "this district" what do you mean?

A. The Passaic Valley Sewerage District.

Cross-examination.

By Mr. O'Sullivan:

Q. I understood you to say that you were retained for this present proceeding in March of this year?

54 A. Yes, sir.

Q. What was the first thing you did after your retainer?

A. I read over somewhat hastily the printed record in this case, and then I examined the documents which I had on file in my office pertaining to the subject.

Q. Those were documents that related to early matters regarding the Passaic Valley Sewerage project?

A. All that I had, both the earlier and later documents.

Q. Dating from about 1901?

A. Yes, sir.

Q. You graduated as a chemist from the Massachusetts Institute of Technology in 1890, did you not?

A. Yes, sir.

Q. And then you went with the State Board of Health of Massachusetts?

A. Yes, following my studies and travels abroad, that is so.

Q. How long did you study abroad?

A. I was there somewhat more than six months.

Q. Studying what particular subjects?

A. Bacteriology at the Hygienic Institute of the University of

Berlin, and then I was in the office and laboratory of Piefke; he at that time had charge of the city water filter works of Berlin.

Q. And after that you went with the Massachusetts State Board of Health in 1895?

A. I was there from the autumn of 1890 to early autumn
55 of 1895, yes, sir, about five years.

Q. You were with the Massachusetts State Board of Health, with the exception of the six months that you were abroad, from 1890 to 1895, is that correct?

A. Well, I was with the State Board in 1889, for some four months?

Q. Before your graduation?

A. Before I graduated, then I went abroad in the early spring of 1890, and stayed until November of that year. Then I was continuously with the State Board of Health from November, 1890, until September, 1895.

Q. You were working in the State Board of Health under Mr. Hiram F. Mills, were you not?

A. Yes, I was stationed at Lawrence from May, 1891, on until the close of my engagement, and he was the chairman of the committee of the Board having in charge matters of water supply and sewage.

Q. And you did chemical work, you made tests as to the practical methods for water purification?

A. No, I never have practiced chemistry; I don't suppose more than two or three weeks during my stay at Lawrence. I was on the bacteriological side at that time, and my personal efforts were devoted almost exclusively to the bacteriological side during my first two years at Lawrence.

56 Q. Apart from your studies in bacteriology did you give any special study or take any special course in lectures in biology?

A. Yes, I did take the courses offered by Professor Sedgwick, while I was a student at the Institute of Technology, and I also was his private assistant on sanitary work for several months.

Q. But you didn't specialize in biology, did you?

A. If you mean to study it for quite a number of years and take any advanced degree, you are right, I did not.

Q. And yet in the Massachusetts State Board of Health reports you signed yourself "Biologist," did you not?

A. That was the title under which I proceeded in my early beginnings, and that was due to the fact that when I returned from Europe it was at the time when there were raging these various typhoid fever epidemics in the Merrimac Valley, and I was assigned to the staff of the Biologist, who was Professor Sedgwick at that time.

Q. From 1895 to 1899, did you work similar to what you did under Hyram F. Mills, under the Ohio River Commission, did you not?

A. Yes, but the work at Louisville and Cincinnati was more on the engineering side, testing the workability and economy of
57 structures as purifying agencies, but it was generally similar work, which I might classify as that of securing the engineer-

ing, chemical, biological—more particularly to bacteriological phases of purification of processes.

Q. What special subjects did you study when you got your degree as chemist in 1890? Just mention some of the special studies that you took.

A. You mean other than the chemistry course?

Q. Yes.

A. Well, I took a number of courses which were later put into the group of studies known as the Course in Sanitary Engineering, and I mean in particular now, courses, first, in general biology, second, the history of sanitary science; third, bacteriology, and fourth, microscopy. That would cover all special subjects under Professor Sedgwick. Then I took as far as I was able courses in mathematics, which were optional in the chemical course; I mean by that calculus in particular. Then I took more of the subjects in physics and in regard to chemistry I got to an absolute minimum of subjects of organic and industrial chemistry, and specialized in sanitary work, that is, as pertaining to the analysis of water and sewage.

Q. That would reach to the oxygen content and to the bac-
58 teriological condition of water?

A. Yes, I devoted a great deal of time and spent a summer vacation on special assignments along those lines.

Q. And that was the line of work that you were doing under Mr. Hermany at Louisville, was it not?

A. There I branched out more particularly into the engineering side on account of that being a newer line of work, that is, those mechanical filters and electrolytic devices for purification; that cause-, so far as my own efforts were concerned very much more attention being given to the engineering side.

Q. What was Mr. Hermany's profession?

A. He was an engineer, and at the head of the engineering and operating department of the local water works at Louisville, the title was Chief Engineer and Superintendent.

Q. At Cincinnati, under Mr. Bouscaren, what particular work did you do?

A. That was very similar to the work which I did at Louisville; in the first place, I had charge of the preparation of plans and specifications and the installation of a test plant for testing sedimentation and filteration devices, and I had charge of the operation of that plant for a year or so, prepared the various reports, had chemists and bacteriologists on my staff, and looked after that, as I had
59 been saying, in connection with each of those investigations, from an engineering, chemical and bacteriological viewpoint.

Q. When you say "Engineering" what do you include in that; do you include the structural or construction work or anything of that kind?

A. I gradually got into that pretty actively; at Cincinnati we had a large test plant, with many settling basins on a hillside, and I certainly got into the question of foundations, pile foundations on a sloping hillside; I had a good deal to do with foundations, but that was incidental to my work. The main engineering aspect of the

work pertained to rates of filtration, the frictional resistance of filters with different size sand grains, different thicknesses of sand layers and the flow of water, and the cost of construction of filters of different kinds per million gallons of capacity. That led at the close of my engagement to preparing a statement or general specification of what the outcome of those tests signified as to the purification works for the entire system and the estimate of cost of the same.

Q. And that line of investigation related to the efficiency of sand filters?

A. Sand filters and mechanical filters.

60 Q. What mechanical filters were used there?

A. It was furnished by the Jewell Filtration Company; it was a mechanical filter in which the layer of sand was cleaned up and revolved a rake arm which stirred up the sand and cleaned it with the aid of a stream of water applied at the filter floor.

Q. Reports were made on these Louisville experiments and on the Cincinnati experiments; do you recall how you signed your portion of those reports?

A. At Louisville I signed it as Chief Chemist and Bacteriologist. I am not quite plain in my recollection what it was at Cincinnati.

Q. Was there any construction done there at that time while you were connected with the works at Louisville and Cincinnati?

A. Not at the time; all preliminary investigation. I was later called back to each of those places in connection with the construction work.

Q. You became a partner of Mr. Rudolph Hering in 1901 and continued that partnership until 1911, is that right?

A. Yes, sir.

Q. And that firm was engaged by the Passaic Valley Sewerage Commissioners to formulate plans for the relief of the Passaic

61 Valley District from the nuisance conditions here in the Passaic Valley?

A. Yes.

Q. In the investigation which you have alluded to as being contained in documents that were in your office, what portion of the work was assigned to you?

A. You are speaking now of the Passaic Valley Sewerage investigations?

Q. Yes, between 1901 and 1911.

A. The work that I came more particularly in contact with related, in the first instance, to the quality and quantity of sewage and the purification processes which were studied in connection therewith. I also looked after the executive administration end, in the absence of Mr. Herring and was associated with him generally. A good many of the aspects of the case—I don't want to give the impression, however, that I was working on the more strictly engineering aspects of the case when Mr. Herring was present; that is not true; I was interested on construction work elsewhere.

Q. Who formulated the plans for the relief of the Passaic Valley District during that period, from 1901 to 1911?

62 A. In 1901 that matter was taken under consideration and advice was given by Mr. Hering in conjunction with his associates on this special board of engineers reporting to the State Sewerage Commission; the associates were Mr. Brown and Mr. Croes.

Q. Did you do any of the designing for either the trunk sewer project or for the disposal works or for the tunnel scheme?

A. You mean independently of before now?

Q. At any time?

A. So far as the flow of sewage is concerned, the design in the sense of fitting the capacity to the needs of the community, I participated in a good many conferences. I also was associated with all of the engineers interested in the subject, in considering slopes and frictional resistance, means of measuring devices, multiplicity of those details—I cannot say that I did that to the exclusion of Mr. Hering or anybody else, but I was a part of the group of engineers that considered and passed upon those matters.

Q. What special work did you do with regard to the solution of that problem presented by the Passaic Valley Sewerage Commission?

63 A. I tried to make plain the question of quantity of sewage and its strength and the population all making for the capacity of the sewer. The question of the location that was a thing that I studied by inspection on the field and conference with our assistants. I hesitate to say that I was the dominating factor in those groups. That isn't the way these large enterprises where there is a large corps of engineers, proceed.

Q. Then as I understand it, Mr. Fuller, you did a little of every portion of the work that was being done, either in the designing and the estimating of the sewage volume, and in all other matters pertaining to the problem; you didn't do any special distinctive work, as I understand it in connection with the solution of that problem?

A. So far as composition of sewage and purification of the sewerage is concerned by treatment works, that I have no doubt went to me more than to anyone else, and in the absence of Mr. Hering I was directing the men of the staff of engineers employed on the work. I think that is about as plain as I can make it to you.

Q. Did the first plans for relief of the Passaic Valley sewerage problem contemplate any sewage treatment?

A. Nothing very substantial.

64 Q. Didn't it contemplate discharging crude sewage into Newark Bay?

A. I think you now are speaking of the 1897 project of Mr. Fatley; that was prior to my connection with the company, prior to Mr. Hering's. That project was, I think 1897. That I had nothing whatever to do with.

Q. Was the sewage treatment proposed at any time in your hearing, either by Mr. Hering or any of the Passaic Valley Sewerage Commissioners, prior to 1906?

Mr. Riker: The question is objected to as not being cross examination.

Commissioner Maher: The objection will be noted.

A. Yes, there was some consideration given, I am inclined to think in 1901 or 1902 or thereabouts, and there were reports prepared by other engineers for treatment of sewage from some of the towns in this Passaic Valley District, in works of artificial construction.

Q. And that dealt with separate disposal systems for some of those communities, did it not?

A. Yes, it did, and I recall in particular about 1906 that Mr. Allen Hazen made a report for the treatment of the sewage of Paterson as an independent project.

Q. And he recommended to the City of Paterson to enter
65 the Passaic Valley Sewerage Commissioners' project, provided that no sewage treatment was in contemplation?

Mr. Riker: The question is objected to on the ground that it is not cross examination, and the advice as given is not properly testified to by this witness.

Commissioner Maher: The objection will be noted.

A. I don't think that he qualified it in that way. I think that he advised them to join in the trunk sewer, and with the sewage of the Passaic Valley trunk sewer to be discharged into New York Bay.

Q. Without treatment?

A. That is without complete treatment, without substantial treatment; put it that way; although I am not perfectly clear in my recollection without reference to detail.

Q. I will see if this will refresh your recollection, Mr. Fuller; I read from report on Sewage Disposal of Paterson, New Jersey, by the engineer who calls himself Allan Hazen, page 107, under the heading of "Recommendation."

"I believe that the interests of Paterson will be best served by joining with other municipalities in the construction of a trunk sewer to take the sewage from the entire district requiring sewage disposal facilities in the Lower Passaic Valley to a point of adequate sea water dilution, either in New York Bay or Newark Bay, near the
66 Kill von Kull. I believe that this arrangement will be substantially better for Paterson than a separate local purification of the sewage.

If, however, great obstacles to this arrangement should be found or if it should be necessary to purify the sewage collected in such a trunk sewer before discharging into the salt water, then, clearly, it will be for Paterson's best interests to purify her own sewage near home."

Does that refresh your recollection, Mr. Fuller?

Mr. Riker: The question is objected to as not cross examination, and immaterial and irrelevant.

Commissioner Maher: The objection will be noted.

Q. Are you now looking at a copy of his report?

A. Yes, I am. I know what is said in the quotation which you have read.

Q. Then I ask you was any sewage purification scheme in contemplation in 1906 when the report was written?

Mr. Riker: Same objection.

Commissioner Maher: The objection will be noted.

A. Apparently not; not by me. I don't know who was considering it. This was before the Hering and Fuller work of 1907 and 1908.

Q. As far as your knowledge goes, Mr. Fuller, when were the plans and specifications first formulated for sewage disposal system for the Passaic Valley Sewerage Commissioners?

67 A. That is no- the line serving as the basis for the present works as executed, and is that the particular step in the series of considerations that you have in mind? The present plans, substantially in their present form, were prepared in 1907 and 1908; I should say the work began in the autum- of 1907 and continued for perhaps eight or ten months.

Q. The construction that you say you inspected somewhere between March and the present time, did that construction follow along the lines of the plans designed somewhere around 1907 or 1908 as you have just described?

A. I should say that the very brief outline plan of 1907-'08 did not show the sedimentation basins that I have been testifying to here today. I think that arose at a later date.

Q. Do you remember the Harbor Line hearing in December, 1908, when the Passaic Valley Sewerage Commissioners applied for a permit for a trunk outlet sewer in New York's Upper Bay?

Mr. Riker: You mean Upper New York Bay.

A. I think not. I have attended a number of conferences there, but I do not think I was present at that time.

Q. Were there any plans formulated in 1909, prior to June of 1909, for the relief of the Passaic Valley Sewerage Commis-

68 sioners' problem?

Mr. Riker: That is objected to on the ground that it is not cross examination and is not relevant to the inquiry in this cause.

Commissioner Maher: The objection will be noted.

A. I am inclined to think that the plans for treatment came to the front during 1909 as a result of conferences with representatives of the Federal Government. I am a little uncertain as to my recollections, whether that should be March or June or November. I haven't the information before me.

Q. Mr. Fuller, will you take a copy of Complainant's Exhibit 135 that you used in testifying today, and I ask you when the plans that are specified in that stipulation were designed or formulated for the sewage disposal system?

A. This particular exhibit refers, as I understand it, to the communication addressed to the Passaic Valley Sewerage Commissioners, by Mr. Hering, Mr. Harrison and myself. They referred to sedimentation basins, and that communication is dated March 25, 1909.

Q. That is Defendants' Exhibit 5, is it not?

A. Yes. And the exhibit to which you make mention, being the stipulation between the United States Government and
69 the Passaic Valley Sewerage Commissioners, I note that that was executed on the fourteenth day of April, 1910. These plans I have no doubt, came into being in between those two dates.

Q. That is, between March 25, 1909, and April 14, 1910?

A. That is true, yes, sir, as far as I am able to state.

Q. Were any plans in existence on March 25, 1909, that Defendants' Exhibit No. 5 alluded to?

A. I am unable to say specifically as to that precise date, but the facts were that at or about this date of March 25, 1909, Mr. Edlow W. Harrison, who was at that time in active charge of the engineering work for the Passaic Valley Commissioners, that is, of the designing force did prepare some outline plans which were attached to documents and presented to the various interested parties in this controversy. I am afraid I cannot particularize further as to detail.

Q. Do you know who dictated Defendants' Exhibit No. 5, which you signed?

A. I think that is a composite effort representing the thought of the three men who signed it.

Q. And you were familiar with the contents of that communication before you signed it, were you not, Mr. Fuller?

A. Yes, sir.

Q. Will you explain to me what is meant by the second
70 paragraph which begins:

"This statement is prepared for the purpose of securing co-operative action to decide the details of this method, in a manner satisfactory to the parties in the pending suit between the States of New Jersey and New York and the United States, in accordance with the understanding arrived at during the conference held in the office of Attorney General O'Malley in New York City on March 11, 1909."

Will you explain to me, Mr. Fuller, what is meant by that paragraph when it is said that it was to secure "co-operative action to decide the details of this method," if the method was already in existence?

A. Well, the method was satisfactory to the parties to the pending suit was under very active discussion then, particularly with Colonel, now General Black who was the Chief Engineering Officer of the United States Army Department of East and also of the New York Harbor Line Board; a plan of procedure was under discussion at a large number of conferences, and this particular conference in the office of Attorney General O'Malley led to a certain size of design as being satisfactory to General Black and to the representatives of the State of New York as far as my recollection goes.

Q. And this was a tentative proposal that might be satisfactory and was presented for that purpose, was it not?

A. The reference to the screens and sedimentation of those treat-

ment works, that was reducing to writing what had orally
71 been discussed at numerous conferences prior to that time.

Q. And was tentative to secure co-operation?

A. To secure co-operation in the sense of bringing to a close the pending lawsuit, the injunction suit, that is true.

Q. That was framed for the purpose of securing the meeting of the minds of the various contesting parties, as to what would be satisfactory to all parties?

A. I think that is a correct statement, and representing the outcome of numerous conferences of the interested parties prior to that time.

Q. In your testimony, Mr. Fuller, you alluded to plans and specifications for the sewage disposal system to be operated by the Passaic Valley Sewerage Commissioners on the Newark Meadows; did that include anything other than the plant described in Complainants' Exhibit No. 135?

A. No, I think not; in fact, the structures now being built are in very close conformity with that stipulation, as to size of basin capacity, length and velocities—literal compliance with it.

Q. Do you know whether or not the plans and specifications designed and formulated by Edlow Harrison and William Gaven Taylor late in 1910 had been adopted and are in any way
72 being put in operation through this construction that you have described?

Mr. Riker: The question is objected to as not cross-examination and being irrelevant and immaterial.

Commissioner Maher: The objection will be noted.

A. I am hardly possessed of information to allow me to make a very specific response to that question, but speaking from my general information, I am quite clearly of the opinion that these basins as built were certainly reconsidered by Mr. Brown, the present chief engineer, and Mr. Taylor, who is also deputy chief engineer. I should say that was 1915, although I am not quite clear in my recollection concerning the date. I made no attempt to develop historically the details which may have been considered by persons outside of my own office.

Q. Have you read carefully the description given of the plant that is expected to produce the effluent described in the stipulation marked Complainants' Exhibit 135?

Mr. Riker: The question is objected to on the ground that effluent is not described in the stipulation and on the further
73 ground that it is not cross-examination and is irrelevant and immaterial.

Commissioner Maher: The objection will be noted.

A. Yes, that is the stipulation that is executed to the Federal Government, that is right, is it not?

Q. Yes.

A. Yes, I have read that description of the plant as it appears in that document.

Q. And your answer today with regard to modifications or changes that could be introduced and that might be beneficial, relate to the plant described in complainants' Exhibit 135?

A. Yes. Perhaps I should say that I am answering that "Yes," having in mind specifically the sedimentation basins. There is some minor changes in the screen situation as I have explained. The tanks are being built as set forth in this stipulation, which is Complainants' Exhibit 135, and are now actually being constructed.

Q. In the description of that plant, Mr. Fuller, under the heading of Stipulation and sub-head First, paragraph (a): "Upon the line of the trunk sewer which it is proposed shall be constructed and at a point at or near the pumping station to be located
74 on the Newark Meadows near the Newark Bay, it is stipulated and agreed that the sewage, waste and other matter passing through the said trunk sewer shall first pass through coarse screens to remove therefrom all large floating matter," have you any change to suggest in regard to that feature of the plant?

A. No, they are built as specified and I have no suggestion to make concerning modification thereof. They are in reference to protection of pumps and not the sanitary aspect of the case.

Q. I understood in your direct testimony, Mr. Fuller, that you had read the order of the Supreme Court of the United States in this matter, dated March 10, 1919?

A. Yes, I have.

Q. And that the State of New Jersey was undertaking through you to give any practical modification of the proposed system of sewage disposal of the Passaic Valley Sewerage Commissioners?

A. Yes, that is the portion of the order that I have directed my attention to.

Q. And continuing from where I stopped in paragraph (a): "And after passing through such coarse screens shall pass through a grit basin or basins where the heavy matter therein shall be taken out as far as practicable, from which basin or basins the sewage and other matter shall pass through self-cleaning mechanical screens having clear openings of not over 4/10 of an inch." Have
75 you any additions or modifications, either as to construction, arrangement or operation, in relation to what I have just read, in order to increase their efficiency, Mr. Fuller?

A. No, I have not.

Q. "(b) As the sewage comes from the fine screens, it shall also pass through sedimentation basins. The sewage after passing through said grit basin and self-cleaning mechanical screens shall enter the sedimentation basins, or settling tanks consisting of a number of units, each approximately 225 feet long and 15 feet deep." Have you any suggestion to offer with regard to increasing the efficiency of what I have just now read with regard to the sedimentation basins?

A. Yes, I have testified at some length on the desirability of making the unit of 225 feet approximately subdivided into three subunits with a travel of one-third of that distance, and with a velocity of a flow one-third thereof.

Q. And with the object of increasing the detention period by the suggestion you are offering now?

A. No, with the specific purpose of lowering the velocity of flow and not increasing the period of detention.

Q. What advantage, then, would it offer?

A. It would allow a greater removal of those solid matters capable of sedimentation.

Q. Although it would not increase the detention period; decreasing the velocity of one-third would not increase the detention period in the sedimentation tanks?

A. No, by having the length of travel only one-third the detention period would be the same. Let me make that plainer, perhaps. The same volume of sewage would go to one of these basins, according to my proposed arrangements, as at present, but in that outlet connections would be modified so that only one-third of the volume would go to one end and travel not the full distance, but one-third of the distance. Then down at that point you take another one-third of the sewage and let it travel, we will say, a second unit, one-third of the total length, and so on, and as you divide the flow into thirds, and let each third travel one-third of the total length, so that the period of detention would be the same.

Q. And you would decrease the velocity by either increasing the number of units for the sedimentation tanks, or by subdividing the tanks?

A. Yes, I would increase the efficiency by lowering the velocity and making subdivisions of existing tanks, too, and add more new basins.

Let me just make one statement on that question of feces, with a view to making my position plainer: The solid matters which will deposit from sewage as they pass through a basin seem to separate into two classes, whether they are settled or not settled—subsidable solids versus non-subsidable solids, with respect to what is called a critical velocity of about one-third of an inch per second. That means, that if you get a velocity of flow in excess of about one-third of an inch per second, you begin to move, irrespective of the length of travel, some of your particles from inlet to outlet; whereas, if you had a lower velocity you would not carry them out; that is, the feces commences to fall off theoretically when you increase your velocity above about one-third inch per second, and when you get to a half inch per second, it is quite noticeable, and if you get up to an inch per second, it is quite substantial. My thought in making this proposal is to reduce the velocity so as to eliminate substantially all of those sewage solids which are capable of being deposited in tanks.

I might make one other explanation here of the earlier view point on velocities, and that is, at all times when I had anything to do with the discussion of sedimentation tanks for the Passaic Valley project, it has been the purpose to reduce the velocity in the tanks to a lower velocity than would actually be experienced by the sewage when it

reached New York Harbor, on the theory that all matters
78 would be deposited from the sewage before it went into the bay, and there would be no deposit of sewage solids in New York Harbor so far as Passaic Valley sewage is concerned.

Q. In making your estimate for the Passaic Valley trunk sewer volume of sewage, did you include trade wastes, Mr. Fuller?

A. Yes, there was a certain allowance made for trade wastes.

Q. What allowance did you make?

A. Equal, to ten per cent of the volume of sewage.

Q. When you use the generic term sewage, you calculate that ten per cent of the Passaic Valley trade waste will be accommodated in the trunk sewer?

A. Yes.

Q. What is to become of the other ninety per cent of the trade waste that would not be accommodated in the sewer?

Mr. Riker: That is objected to on the ground that it is not cross-examination and is irrelevant and immaterial.

Commissioner Maher: The objection of counsel will be noted.

A. That involves a statement from memory of the policies that surrounded the treatment of results in the Paterson and Passaic Districts as they were stated in 1907 and 1908. That matter has been investigated by the Mill owners and also by Mr. Hazen
79 and Mr. Whipple, who made this Paterson report from which you read extracts which was just considered feasible in connection with the silk dyeing and other textile industries to separate the water used in washing different goods that were just slightly stained. That had some slight amount of acid or chemicals in them, from those which would be very heavily impregnated with the dyeing chemicals, such as the spent dye itself. This theory of procedure and the possibility of this Passaic Valley Sewerage designed was founded strictly on the basis that the spent dyes and heavier wastes to the extent of ten per cent of the capacity and volume of the sewage would go into the sewer, and the other ninety per cent would be kept by suitably arranged drains at the industrial establishment. That would represent the wash water, that would go directly to the river.

Q. And the heavily impregnated trade waste would be taken in the sewer?

A. Yes.

Q. In testifying you have made the distinction between those solids which are sedimentable and those which are non-sedimentable. How do you class the colloids in this subdivision—colloidal matter?

80 A. Colloidal matter would not subside as a general proposition; they would be grouped together into masses as the result of some chemical action, but for the most part they would not subside. Some of them would be attached, of course, to the surface of the ordinary sewage solids, and would be deposited in that way.

Q. Would you consider that percentage large or small?

A. I should think it would be substantial; I wouldn't attempt to say how much.

Q. And the trade waste from the silk dyeing and silk manufacturing plants in Paterson and from the large woolen mills of Passaic would be very largely colloidal, would they not?

A. The spent dyes would show some colloidal matter, yes.

Q. Don't they use a great deal of soaps and organic matters that are in a colloidal condition?

A. I don't regard soap as a colloidal matter; I would consider soap curd would be large enough to deposit and appear as solids in the bottom of the sediment basins.

Q. A soap solution you would not regard as colloidal substance?

A. I assume there is colloidal matter in the soaps, some of which I should say would be in what we ordinarily call a solution, and a good deal of the soap would be practically as a curd, it would
81 be in a solid form. I don't know just in what proportion they would be in the form of colloids.

Q. How would you define colloidal matters, Mr. Fuller?

A. Speaking as an engineer, I would say that it is a substance in a state of suspension, so fine that it would not respond to the laws of subsidence. I suppose from a chemical viewpoint one might describe it as something that is not in a state of true solution; that is, it is not like sugar or salt, that it would form a crystalline solution; it would be more like gelatin, which is intermediate between the two.

Q. As a chemist what would you use as the antonym to colloidal?

A. I don't remember.

Q. Would you use crystalloidal?

A. It might be used.

Q. Isn't it the word that is used by chemists everywhere?

A. I think very likely it is; I am not very proficient in those terms.

Q. The suggestion that you have made now with regard to the sedimentation basins, would you expect a larger percentage of sedimentary matter from the colloidal trade waste of Paterson and Passaic as the result of that suggestion?

A. Obviously if they are not responsive to the laws of
82 subsidence, they would not be affected by it. Those colloids coming from the trade wastes of Paterson, that would be bunched or massed together as the result of Chemicals being used for fixing the by-product onto silk or woolens and those particles of the colloids which would adhere to the surface of the sewage solids, those would go to the bottom of the settling basis, but if they were not massed together by chemical agencies, or they were not attached to the surface of larger sewage solids, they would go right through the basin, I don't know just what proportion.

Q. You would have among those three different groups of colloids as they would reach the sedimentation basins these colloidal matters which are very highly putrescible?

A. No, that isn't my understanding of it. There is ample of putrescible matters from the textile industry which result from the

cleaning of both silk—particularly silk goods; it is a fact that that organic substance is highly putrescible.

Q. You mean those gums and oils and substances?

A. Yes, that is the only line of waste products from the silk industry that is very highly putrescible so far as I know.

Q. How about wool washings from Passaic?

83 A. I don't believe Passaic is a wool scouring district.

Q. Haven't they the largest woolen mill in the world in Passaic?

A. They have a very large dyeing textile mill there; it is not a scouring mill, Botany Worsted Mills, but it is not my recollection that this is a good wool scouring establishment. They get clean wool; I may be wrong, though.

Q. Aren't the trade wastes from a woolen manufactory very putrescible?

A. Leaving out wool scourings, the cleaning of the crude wool, I think not. There is some organic matter, of course. I have been associated with the Botany Worsted Mills, in the amount of water they use in the dyeing industry. I am pretty sure from my contact, that they are not wool scouring people.

Q. How much water do they use to a pound of wool manufactured?

A. I wouldn't state that from memory. I designed a water filter plant which is about 3,500,000 gallons for twenty-four hours.

Q. How much water do they use to a pound of silk?

A. I cannot tell you that from memory.

Q. Over 300 gallons.

A. I don't know.

Q. Have you any idea of the average amount of organic matter that is used in silk manufacture?

84 A. I have had occasion to study those things pretty carefully, but not for several years. It is the silk gum in cleaning the raw silk which does produce a good deal of putrescible matter, but beyond that stage of the matter, I am of the opinion that the amount of organic matter is not great.

Q. And the ten per cent of trade waste that you take from Paterson would contain, first, that highly putrescible matter?

A. That was the intent, yes, sir.

Q. Mr. Fuller, I continue reading at paragraph marked (*b*) in the stipulation which describes the plant that undertakes to produce the effluent described later:

"Each tank will have a normal capacity of not less than 1,500,000 gallons, making an aggregate tank capacity sufficient to meet the requirements as stated herein. The tank capacity shall always be such as to provide a detention period of not less than 1 hour at the maximum rate of flow of the sewage and a detention period of the daily average flow of such sewage for not less than 1 hour and a half. The mean lineal velocities through said tanks shall not be over 0.5 inch per second for average flow, and 0.75 inch per second for the maximum flow. In addition to and in connection with these basins scum boards shall be provided to retain the floating matter,

and proper and adequate devices shall be used to remove the retained scum and deposits from the settling basins; drawings of the general plan of said settling tanks (sedimentation basins) as proposed at the outset being herewith attached as Appendix A."

What suggestion do you offer with regard to increasing the efficiency regarding these tanks as described in that part of the
85 stipulation which I have read?

A. I would simply divide each of those velocities by one third and allow the basin capacity to remain the same, and allow also the detention period to be the same.

Q. In no case would you increase the detention period?

A. No, sir, I do that, however, on the basis that a distance of travel of 70 feet has been found in the last few years to be sufficient, and it is not wise to prolong that period, because it tends to allow an exhaustion of the dissolved oxygen and would add that much more to the burden of aëration and would do no good. I explained in my direct examination that with the sewage deposited in those pockets in the bottom of the tanks, there is not that scour which resulted from the old flat-bottomed tanks.

Q. Then the only change you would make there would be in dividing the rate of velocity by one-third?

A. Yes.

Q. And that you would accomplish by sub-dividing the tanks?

A. By simply installing the inlet and outlet troughs, one of each.

Q. I continue reading from the stipulation the paragraph marked (*c*):

"The sewage and waste thus screened and settled is then to flow into a pumpwell, whence it is to be pumped under the pressure through a tunnel to a point in New York Bay near Robbins
86 Reef light, at which point it is agreed that the matter passing through the said tunnel shall be dispersed into the waters of the New York Bay through a series of outlets discharging forty feet or more beneath the surface of the water at mean low tide. From the end of the tunnel connections shall be made with four or more discharge pipes extending across the current, spaced about 100 feet apart, laid in trenches on the bottom of the Bay, and of a size decreasing in diameter from about 6 feet to 2 feet. On the top of these discharge pipes will be a series of not less than 150 tees of a diameter not exceeding 1 foot, and spaced approximately 10 feet apart. On each of these vertical tees shall be placed outlets arranged to discharge horizontally across the tidal current, and the extent of the dispersion area used for this system of outlet pipes shall cover at least 3.5 acres of the bottom of the bay."

What changes, alterations or additions would you suggest to increase the efficiency of that part of the stipulation which I have just read regarding the dispersion part of the plant?

A. The actual arrangements being built for dispersion are in conformity with this stipulation, except that instead of these vertical tees, there has been designed a better arrangement, and that is this

dispersing nozzle that I spoke of in my direct examination. That is all that is necessary in my judgment. I think it is the best design that has ever been gotten out anywhere, either in this country or abroad.

Q. The provision in that paragraph which I have read arranged for horizontal discharge, and I understood you to testify on your direct that the discharge would be vertical?

87 A. It is perhaps not quite accurate to say that they are vertical, that is, they are not horizontal, but the sewage would be released from these nozzles, which have flaring sides, so that there would be a thin ribbon of sewage about 2 inches wide released in a flaring direction, and given a marked swirling action as the result of a vane or diaphragm in the nozzle itself.

Q. Are there any additions or modifications of that part of the disposal scheme that you would suggest?

A. No. It is being built in a way that would give thoroughly satisfactory results, I am confident of.

Q. And the discharge will now be vertical instead of horizontal, is that as you understand it?

A. Subject to what I have said in my last answer, that it comes through this nozzle with this swirling motion, as a thin ribbon, and it goes out in a flaring direction.

Q. But the outlet of the nozzle does it face horizontally or vertically?

A. It faces vertically.

Q. So that the discharge would be vertical in the curvature?

A. Yes, as against a horizontal direction, but the out-let goes out as a thin ribbon in the flaring sides.

88 Q. What temperature would you expect the sewage to reach that trunk sewer out-let at Robbins Reef light in weather like we usually have in June, July, August and September?

A. I suppose it would be 65 and 70 degrees.

Q. And the organic matter would be transported in fresh water would it not?

A. Where?

Q. In the sewers?

A. It would reach the dispersion area; it would move along the line of the trunk sewer, if that is what you mean.

Q. There is no salt water in the sewers here and wouldn't be until the discharge at Robbins Reef?

A. No.

Q. The sewage and fresh water are both lighter than salt or brackish water, are they not?

A. Yes.

Q. And no matter how you would discharge them they would rise to the surface of that salt or brackish water?

A. No. On the contrary I am firmly convinced that they would not.

Q. Do you know of any instance where that occurs, where a deep discharge does not reach the surface of salt or brackish water?

89 A. There is no place where there is a dispersion area in deep water 40 or 50 feet or more, where there are these nozzles provided, but in a recent betterment made at the Deer Island outlet there is very nearly a complete elimination of surface appearance of sewage.

Q. When was that change made at Deer Island?

A. I think about a year and a half ago.

Q. What change was made there?

A. You will hear further details of that from Mr. Stearns who has been connected with that.

Q. I am asking you; you are using it as an illustration; I want to see how it illustrates.

A. It is converted to a sub-surface outlet, of which I have the notes, I find, here, indicating that this Deer Island outlet was extended and put in service on December 3, 1917. It consists of adding nine foot lengths of cast iron pipes varying in diameter from 84 to 48 inches. That total length of the extension is 322 feet, and there are nine foot lengths of pipe used in making this extension, and on these pipes there is an opening of which I haven't the exact dimension, I think it is about 14 inches. If I am wrong, Mr. Stearns will later correct that. Those openings are not of this nozzle type, but the reports and information which I gathered concerning that, indicates that it has been very successful in
90 preventing the sewage appearing on the surface, as was noted in the earlier days before these submerged outlets were installed.

Q. How deep is the point of discharge at Deer Island?

A. I think that varies, but it is between forty and fifty feet, as I recall.

Q. And those additions that you have described, do they go in a horizontal direction?

A. They go in a horizontal direction.

Q. What is the volume of discharge at Deer Island?

A. I don't know that I can tell that readily without looking at my notes.

Q. Approximately?

A. About 50,000,000 gallons a day, I think.

Q. And it is largely sewage, or is it equal parts of sewage and trade waste, or how is it composed?

A. It is composed of some trade waste.

Q. Not very much trade waste?

A. Less probably than from the Paterson and Passaic Districts.

Q. And how old would the sewage be at the point of discharge?

A. As far as I can tell, it would be the same, as it is here, that is, from say 12 to 16 hours; it is not fresh sewage.

Q. The estimate is much higher for Passaic Valley sewage
91 according to most of the witnesses who have testified for the complainant. You say the age would be 12 to 16 hours?

A. That is my recollection without making a special study of it.

Q. And that is not visible on the surface of the water, as I understand your testimony?

A. I understand it is substantially free from signs of sewage, that is, the surface of the water is.

Q. Are there any of the other outlets either at Peddocks Island or Moon Island in deep water, that is, is the point of discharge submerged, and if so, to what extent?

A. The Peddocks Island or Nut Island outlet, that discharge is in about thirty feet of water or thereabouts, and the outlet pipes, or one only that is there, is an elbow that looks upward and has a diameter of 4 or 5 feet; there is nothing in the nature of multiple outlets at Peddocks Island, and at Moon Island there has been no adoption of the multiple outlets or submerged. They are discharged practically under the surface, being a release of flow from a basin.

Q. What is the tidal range in Boston Harbor?

A. I think it is approximately 6 feet.

Q. Are you sure that it isn't from 10 to 17 feet?

92 A. I am not speaking accurately, but I have known it, but I don't recall it at the moment. I will be guided by whatever the facts are.

Q. What is the tidal range in New York Harbor?

A. It is four and one-half to five feet.

Q. What is it, four and one-half or——

A. 4.6 feet in the Bay—it may be 4.7; I don't pretend to carry those figures closely in my mind.

Q. Don't they measure the tidal prisms and isn't that an important factor in discussing all problems of sewage disposal by dilution?

A. It is one of the elements that should be considered, yes. I have not recalled that phase in my studies; I am simply indicating that I don't recall from memory precisely all of those details.

Q. With the exception of the sewer out-let at Deer Island and the other one at Peddocks Island, do you know of anywhere else where there are submerged outlets where the sewage is not visible on the surface after its discharge?

A. At New Bedford they have a submerged outlet that gives very satisfactory results; then if you go to the inland waterways at Rochester they have a submerged out-let that is completely successful; there

93 is no appearance of sewage on the surface there. I should make it plain, however, that the sewage coming through the submerged outlet pipe at Rochester has been screened and settled.

Q. And it is also in a swiftly moving body of water, fresh water river?

A. No, it is in Lake Ontario, where the currents at that depth are very slight.

Q. At what depth is it discharged?

A. I think between forty and seventy feet.

Q. Have you read the reports of the International Commission that have been investigating the pollution of these Great Lakes?

A. Yes, I was one of their engineers.

Q. Why was there a necessity for an investigation?

A. So far as Rochester was concerned, there wasn't any necessity, but so far as the connecting rivers between the lakes, like the Niagara River and Detroit River, there had been allowed to develop such conditions as prevail around New York City; that is, the sewage is discharged from the slips and water ways and there is a very decided different element coming into those water ways, and that is the relation of sewage pollution by one community of a stream that serves as a source of water supply for a neighboring community; that is, Niagara Falls, for instance, with its water drawn from the Niagara River, has a burden of its water filter plants that was con-
94 sidered excessive. There has also been, of course, trouble with outbreaks of disease from passengers on the Lake steamers. There are a good many different factors that don't appear in this case here in controversy, but the general movement which prompted that reference to the International Commission is founded upon the proposition of keeping sewage disposal within the controllable limits and it is a movement that is generally recognized as proper and important.

Q. But the investigation was inspired by Complainant against sewage pollution?

A. I should judge that was so. It must have been so considered; otherwise it wouldn't appear as part of its treaty between Great Britain and the United States in 1909.

Q. And Rochester was one of the cities contributing that sewage?

A. In 1909, it was conveying raw sewage in the Genesee River which went out into the lakes. Those works which I spoke of have been in service approximately two years, I should say, entirely subsequent to the records being made to the International Joint Commission for investigating and reporting procedures for the control of pollution.

Q. The Genesee River is a fresh water river that moves
95 its tidal current one way towards the lake?

A. Yes, subject to action of winds, but generally speaking, that is true.

Q. Are there any suggestions that you would make to increase the efficiency of the disposal scheme that I have just read?

A. No, I have no suggestions to make, because I think none is necessary.

Q. But whether necessary or not, you have none to make?

A. I have none to make.

Q. Under the heading Second, in Complainant's Exhibit 135, I read:

"The Passaic Valley Sewerage Commissioners further agree with the United States that in the operation of said sewer system at all times the following result shall be secured, either through compliance with the requirements of the immediately preceding paragraphs, or through requisite lawful additional arrangements."

Did you take any part in the framing of these stipulations, Mr. Fuller?

A. I was at quite a number of conferences where they were discussed, yes, sir.

Q. And you are familiar with the subject matter and with the agreement and its phraseology before you had actually had them framed up as I have read them to you now?

A. You are reading from the stipulation which had the addenda and the phraseology of the legal advisers, whereas the docu-
96 ment which I signed is limited to the engineering phases. So far as performance is concerned they are identical.

Q. In what part of the paragraph which I have read in which the Passaic Valley sewerage Commissioners agree to the results that are to come later, and are defined here, that they shall secure those either through the description given of the plant that we have just read, or through requisite lawful additional arrangements. Who inserted that item there showing lack of confidence in the plant, and providing for some other method of securing the results?

Mr. Riker: I object to the question as framed, on the ground that it contains a conclusion of counsel as to the effect of the stipulation, and which is not embodied in the language of the stipulation.

Commissioner Maher: The objection of defendant's counsel will be noted.

A. It did not come from me and I cannot inform you about it.

Q. Did you express any doubt as to the efficiency of the plant to secure the results that are stipulated?

A. No, sir.

Q. Now what requisite lawful additional arrangements
97 have you in mind that can be added to the description of the plant which we have described, in order to secure the results?

Mr. Riker: That question is objected to on the ground that under the order of March 10, 1919, made by the United States Supreme Court, defendants are permitted to introduce testimony of any practicable modification of the proposed system of sewage disposal of the Passaic Valley Sewerage Commissioners, either as to construction, arrangement or operation, and the nature and character of sanitary or engineering appliances that can be added thereto or introduced therein in order to lessen the alleged polluting effect of the effluent upon the waters of New York Harbor, and not to the language of the stipulation.

Commissioner Maher: The objection of defendant's counsel will be noted.

A. I have testified to modifications within the range and scope of this paragraph one of this order of March 10, 1919, and set forth in my direct examination—shall I summarize those? They consist of the aerating arrangements to preserve the sewage against putrefaction; the pumping of sewage, with storage of sewage at cer-
98 tain periods of the day in the trunk sewer or basins, or both, in order to serve this two-fold purpose which I have spoken about, one of which is to aid in getting scouring velocities above the pumping station, and the other is to secure dilution in the dispersion area on as advantageous a basis as practicable during an in-

terval just before and just after slack water. I have suggested that at the basins themselves this change be made to lower the velocity of flow, and that if in future years there should be gas lifted sludge appear at the outlet, then fine screens should be considered, and under some circumstances in the future I have suggested that chemical precipitation might be adopted for limited periods in very hot weather for promoting the future removal of suspended or organic matter from sewage.

I might say a word in reverting to the dicussions at some of the conferences as I recall, ten years ago or thereabouts, at the time that this stipulation was under discussion, there was attention given to what should New Jersey do in the event that New York proceeded to get its sewage treatment on a basis in excess of that which New Jersey was proposing to do with these arrangements. In other words, as years went by, its population increased, the state of the art changed; there was, I think, on the part of New York repre-
99 sentatives a desire—perhaps I should say of representatives of the War Department and Federal Government—a desire to see that New Jersey should not lag behind, but should come up abreast of what was done by others. That is only a general one. I have no specific recollection as to any comment at all on lawful additional arrangements, but there was a discussion along these lines which I have just indicated.

Q. Colonel Black laid the basis for those stipulations, did he not?

A. Yes, I think he did.

Q. And Colonel Black's recommendations were changed in some particulars, were they not?

A. In that Colonel Black's request, as I remember, was directed to the percentage removal of certain of the constituents of sewage, and that view was discussed at quite a number of conferences and led to the substitution of specific devices rather than to the performance, without reference to the devices involved.

Q. Did he suggest a putrescibility test which was eliminated in fashioning this stipulation?

Mr. Riker: The question is objected to on the ground that it is not cross-examination, and is immaterial and irrelevant.

100 Commissioner Maher: The objection of defendants' counsel will be noted.

A. There was some discussion given to the removal of putrescibility, but I cannot recall just the detail of it. It was certainly the subject of a number of conferences.

Q. But it was not embodied in this stipulation?

A. No; as I say, the viewpoint was departed from in the sense of striking out a specific performance as to percentage removal, and the introduction of devices which were considered at this conference to be reasonable on the part of the Passaic Valley Sewerage Commissioners.

Q. How would you determine whether that effluent was satisfactory or not before it was discharged into New York Bay?

Mr. Riker: The question is objected to as not cross-examination and is irrelevant and immaterial.

Commissioner Maher: The objection of defendant's counsel will be noted.

A. As regards the question of deposits and solids that could be settled at any basins, there is no room for considering inadequacy of performance in my judgment, except in so far as gas
101 lifted particles of sludge might come up from the bottom of the tank in hot summer weather. That would be controlled for the most part by efficiency on the part of the operating staff in getting the sludge removed from these hoppers to their barges for transportation into deep ocean disposal. I have looked at the question in the light of perhaps screens being necessary to retain these. That is the only thing that will bring up the question of deposits in any way. So far as odors are concerned, that is a question of guarding against putrefaction, and the same is true in regard to the dissolved oxygen content. That is, you want to have the sewage as it leaves these basins and enters the tunnel on its way to New York Harbor so equipped with dissolved oxygen that it would not be in a putrefying condition when it reaches the dispersion area. That certainly can be taken care of by aeration—which I have discussed in my direct examination—from two angles; one, aeration along the trunk sewer at Paterson and perhaps at other intermediate points, as the needs come up, so that there will never be allowed putrefaction to set in; and secondly, aeration at the basins on the Meadows during hot weather could be carried out as required, so that there would be no difficulty in that respect.

Q. But at the plant itself, the only method, as far as I
102 gathered from your testimony, that you would determine whether that plant was operated efficiently would be the absence of gasification of the sludge?

A. The absence of sludge lifted particles as in consequence of gasification down below. Perhaps I have not understood clearly your viewpoint. There is no doubt that a plant of this magnitude would be provided with a laboratory, sample-taking facilities and sample-analyzing facilities so that those matters that I have spoken about should all be kept under careful control. That I am perfectly aware of. It is not a thing that can be left to any haphazard operating program.

Q. But as far as these stipulations go, there is no way that you could determine the condition of the effluent before it is discharged, is there?

A. Well, I am not making myself plain. There is specifically the opportunity to collect samples and see whether the effluent leaving the plant, entering the tunnel, would be free from gas lifted solids. If a control of gas lifted solids is brought about and prevented by adequate cleaning or by screening, there will be no difficulty at all with regard to the solid matter. The dissolved oxygen

ontent has got to be watched, and if there should be a deficiency, that has got to be corrected by re-aeration.

163 Q. But there is no provision made for any test of that kind in these stipulations that are now under discussion, as complainant's exhibit No. 135?

Mr. Riker: That is objected to on the ground that the stipulation speaks for itself.

Commissioner Maher: Objection of defendants' counsel will be noted.

A. There is not set forth here any test of the quality of the effluent; that is something that has got to be actually developed in the operating program of the plant.

Q. And no provision is made for that in the stipulation?

A. It is not put into this stipulation, but everybody has assumed and it seems to me it is obvious, that there must be an adequate operating force with laboratory facilities and there must be a record kept as to the form of this effluent of solid matters which would form deposits, and if there is deficiency in oxygen it must be recognized at once and corrected.

Q. And you are assuming that these facilities will be supplied?

A. I think that goes without saying, an investment of this magnitude in a work of this character, so far as my experience goes with several dozen of these plants, after we built them, we certainly have seen that they have been operated efficiently. I take

164 it for granted that that will be so here.

Q. You have examined the plant at some recent time, have you not?

A. This existing plant now building?

Q. Yes.

A. Yes, I was here during the first week in April and visited the plant.

Q. Did you find in preparation there the allotted place for laboratories?

A. Yes, there is plenty of room in the pumping station for laboratory facilities.

Q. There has been a part of the building set apart for laboratories and it has been pointed out to you as the place where laboratories would be located, is that true?

A. That is my recollection.

Q. Who pointed that out to you, Mr. Fuller?

A. Either Mr. Brown or Mr. Taylor.

Q. You don't remember which?

A. No; it is a very spacious building they have for their pump house.

Q. But they pointed out to you some special part of the building that was given up to be used for laboratories?

A. Yes, that is my recollection—the end of the building next to the Newark Bay.

165 Q. And did they tell you what the laboratory force would consist of, or what the function in the laboratories would be?

A. No.

Q. And they hadn't any separate equipped space for laboratories when you were there?

A. Yes, as regards a room within the pump house, but not as regards a separate building.

Q. But a separate part of the main building?

A. Yes.

Mr. O'Sullivan: Might one of my experts visit the plant, Mr. Riker for the purpose of making an examination?

Mr. Riker: I see no reason why he could not. You understand, it is not equipped, it is only a room; the plant isn't near completion enough to require equipment.

Mr. O'Sullivan: You will give permission to one of my experts?

Mr. Riker: I will advise Mr. Brown or Mr. Taylor to send some one with him.

Q. The results, Mr. Fuller, that are stipulated for in complainants' exhibit 135: "(1) There will be absence in the New York Bay of visible suspended particles coming from the Passaic Valley
106 Sewage." You believe that that result will be accomplished?

A. I certainly do.

Q. What result would follow if that effluent was discharged in Newark Bay, as to visible suspended particles?

Mr. Riker: The question is objected to as not cross-examination and as being irrelevant and immaterial.

Commissioner Maher: The objection of defendants' counsel will be noted.

A. You say visible particles or deposits?

Q. You have the language right before you, Mr. Fuller, as described in the stipulation, complainants' exhibit 135: "(1) There will be absence in the New York Bay of visible suspended particles coming from the Passaic Valley sewage." I now ask you what results would follow the discharge of that effluent in Newark Bay as to these visible suspended particles?

Mr. Riker: My objection is repeated.

Commissioner Maher: The objection will be noted.

A. If the conditions of Newark Bay were the same, the result would be the same, they would not be visible, but I have not studied Newark Bay, I am not sure about the depth of water at the dispersion area over the nozzles, the volume of water or the velocities. If the conditions are the same, the result will be the same, but
107 it is my impression in Newark Bay you could not get the depth or could not get the velocities, or the volume for dilution.

Q. Then you are depending upon New York Bay to do the work that will secure this result; is that it?

A. So far as eliminating the visible suspended matter that dilution is a factor, that this sewage as it leaves these tanks will have

enough suspended matter in it so you will get the appearance of a liquid that isn't perfectly clear. That is true, but a dilution of a certain fold will eliminate that so you cannot see it. That dilution whether it is twenty or thirty times, will be readily secured in New York Bay. Whether it is capable of being obtained in Newark Bay or not I haven't made any study of, and I am not in a position right now to state.

Q. How will the waters of New York Bay cause those visible suspended particles to disappear?

A. By dilution below the point of ready detection by the eye. Let me explain what I had in mind: Take the ordinary sewage from an industrial valley and pass it through sedimentation tanks, I presume that in a general way you would say that the remaining suspended particles, representing the difference between the sixty and
108 one hundred per cent, would be say forty per cent; that forty per cent of the solids remaining might be one hundred parts per million or one hundred and twenty-five parts per million. That seen in a bottle would indicate a lack of transparency; it would be visible. If you dilute that down, so that the suspended particles would be six or eight parts or less, I don't think it would be discernible. I speak of that, based on my common experience in a good many water purification plants, as a practical operating man; you get the turbidity or suspended particles below seven or five parts per million, or thereabouts, it is considered clear water, no visible suspended matter. That is the reasoning that I am using in giving a ratio which shows the need of a diluting factor to bring you from 100 parts down to 5 parts.

Q. And for that result you depend on volume of water?

A. On the dilution.

Q. On the volume of water?

A. For dilution, yes, sir.

Q. The condition of the recipient water, do you take that into consideration at all, as to pollution prior to the discharge of the effluent?

A. Yes, sir. That has been discussed a great deal, and it is a fact, if you have no other sewage going into New York Bay other
109 than the Passaic Valley, you would not be able to detect this settled sewage on account of the turbidity and the vegetable stain which reaches the harbor from the upper Hudson.

Q. How many communities contribute sewage to New York Upper Bay?

A. I really hesitate to say; it is several dozen; I cannot tell you off hand how many.

Q. Isn't sewage brought down, to New York Bay, from above Troy?

A. Yes, I will be guided by whatever the facts are; I cannot tell you off hand. It is a sizable number of communities.

Q. Do you know what the conditions of those waters are in New York Bay as to their digestive capacity for added sewage burden?

A. Yes, I have considered that.

Q. In reference to the proposition of how many persons can discharge sewage into New York Bay?

A. I had these factors in mind in answering the question on my direct examination concerning fifteen or twenty millions of people.

Q. Mr. Fuller, will you give me the data on which you based that opinion; what factors do you use in making that calculation?

110 A. I have taken the volume of water, that is sea water and upland water from the Hudson river in particular; I have noted the figures of Mr. Parsons and Colonel Black and Professor Phelps and of Mr. Hazen. I have notes which I wish to consult. I have considered Mr. Hazen's average flow of new sea water equivalent to 68,000 cubic feet per second, and Mr. Parson's corresponding figure of 76,000 cubic feet, per second, and the Black and Phelps estimate which averages for new sea water without reference to land water, a figure of 87,000 cubic feet per second. I have considered the estimate of Colonel Black and Professor Phelps indicating that new sea water alone will take care of the sewage flow of 7,400,000 people on the provisos that the dissolved oxygen content would be reduced only to 70 per cent, and on the proviso that it would be dispersed so that the full effect of this new sea water could be secured; that is, sufficiently close to the points of entrance at the Narrows and Throggs Neck. I have considered my own dissolved oxygen quantity of about 25 per cent as against the 70 per cent factor of Professor Phelps. I have considered the actualities as they stand during the recent year, taking into account that the dispersion has not been advantageously made with regard to bringing the sewage in con-

111 tact with the diluting water, so as to avail of the dissolved oxygen therein. Another factor that I have considered is the utilization of oxygen now by accumulations of sludge around slips and certain portions of the harbor, such as Gowanus Canal and Wallabout Channel and Newtown Creek, places where sludge accumulates during the winter and spring months, possibly for a year or more at a time, and thus throwing a load onto the dissolved oxygen during the summer months which I believe to be very readily corrected by dredging operations. I have also considered the dilution factors and the benefits that would be secured by clarification arrangements that had been proposed for New York City, and in some measure approaching the efficiency of sewage treatment as will actually be put in effect by the Passaic Valley Sewerage Commissioners. I stated a range of fifteen to twenty million, feeling that it is a matter of judgement, rather than a matter of precise computation; that is, opinions vary; some people give more weight to one element, and other people to other elements, but it is that series of factors which I have considered collectively in leading me to form an opinion which I have stated concerning the number of people that could be taken care of properly in respect to sewage disposal in New York Harbor above the Narrows, or thereabouts.

112 Q. And that estimate is predicated on sewage treatment of all the communities?

A. I would say that that is true at 15,000,000, but it would have to be certainly true as far as eliminating these sewage sludge deposits which are now such a factor in eating up oxygen, and I think that for 20,000,000, you would have to assume that the great bulk of the people would have to have sewage treatment.

Q. How many people do you estimate are now contributing sewage to New York Upper Bay?

A. It is between six and seven millions.

Q. What is the population of New York City?

A. I think that it is a scant 6,000,000, so far as I recall, without having my figures at hand. I think the last figure I saw was something like 5,600,000.

Q. And what is the estimate for the population of the riparian communities of New Jersey that are contributing sewage?

A. It ranges from 350,000 to 400,000.

Q. That includes what cities?

A. It includes Bayonne, so far as it is discharged to the east, and Jersey City and Hoboken, and there is not much population north of the north Hoboken line, there is some, but the ridge line on the Palisades is so close to the Hudson River, I don't believe there
113 is much population.

Q. What is the population of Weehawken?

A. I cannot tell you from memory; I should think it would be less than 10,000 people.

Q. And all the way along the Hudson river during the freshets and summer all the deposits from sewage are brought down to New York's Upper Bay?

A. Yes, they reach there in time. That riparian population of New Jersey as of the 1910 population I think is 283,000 and you have nine years' increase; that leaves me to give this range in figures that I have just stated.

Q. Are you reading from the census now or from your calculations?

A. From the calculations and notes that were prepared, it is possible that they may have come in the record of this testimony. It may be one of the Metropolitan Sewerage Commissioner's report.

Q. Have you read Mr. Kuichling's testimony in this case?

A. Yes, and where that shows that all the calculations on the population of the Passaic Valley and on the riparian communities for 1920, had been exceeded according to the United States census in 1910. If that information was available six or eight years ago, it was no doubt taken advantage of by the United States census
114 bureau in recent years. It is a fact further that the war has brought an unusual increment to some of the communities.

Q. On the application for the permit for the trunk sewer outfall, it was testified before the Harbor Line Board that the Passaic Valley Trunk Sewer would accommodate the sewage and trade waste from one-third of the population of the entire State of New Jersey. Have you any reason to doubt that?

Mr. Riker: I object to the question on the ground that it is immaterial and irrelevant, and I do not want to object to the accuracy of counsel's statement of the contents of the record, but I should say that in my opinion, for the purpose of the objection, the statement cannot be received in evidence.

Commissioner Maher: The objection of defendants' counsel will be noted.

Mr. O'Sullivan: I am now referring to Complainants' Exhibit No. 1, in the testimony given before the Harbor Line Board, which is a part of this record, and my inquiry is directed as to whether or not this witness' testimony as to the population of riparian cities in New Jersey is based on an erroneous calculation or on the actual
115 figures of the census of the United States in 1910?

Witness: I have not given the matter any study; I don't know.

Adjourned to Thursday, June 5th, 1919, at 10:30 A. M.

116 United States Supreme Court.

THE PEOPLE OF THE STATE OF NEW YORK, Complainants,

vs.

THE STATE OF NEW JERSEY and PASSAIC VALLEY SEWERAGE COMMISSIONERS, Defendants.

Continuation of Testimony Taken in the Above-entitled Cause before James D. Maher, Commissioner Appointed by the Supreme Court of the United States, at the Office of Messrs. Riker & Riker, 164 Market Street, Newark, New Jersey, on Thursday, June 5th, 1919, at 10:30 a. m.

Present: Counsel as before stated.

GEORGE W. FULLER resumes the stand for further cross-examination by Mr. O'Sullivan:

Q. Mr. Fuller, can you give me an approximate estimate of the increase in population in the Passaic Valley Sewerage District within the past five years?

A. I should place it in approximate terms at 150,000 people as the increase during the past five years, although I have no precise
117 basis for that. There isn't an annual estimate made, so far as I know, of the population of the different municipalities in the sewerage district.

Q. And has that increase in population been attended by an increased number of manufacturing plants creating and discharging trade wastes?

A. I don't think that the manufacturing plants which would discharge trade wastes would be correspondingly increased, if we consider the past five years. By that I mean to imply that the war program has brought great activity in lines other than textile industries in the Upper portion of the district where relatively large volumes of wastes are found, but there has been, of course, a substantial increase in manufacturing generally speaking.

Q. Where are the trade wastes from the Butterworth-Judson manufacturing plant discharged?

A. I am not informed in detail about that.

Q. What do they manufacture, the Butterworth-Judson corporation?

A. I am not informed.

Q. Do you know whether or not the trade wastes from their plant are particularly poisonous?

A. I am not informed.

Q. Since I put the question to you yesterday in relation to
118 the fact that the Passaic Valley trunk sewer would serve one-third of the entire population of the State of New Jersey, have you had an occasion to look up and see whether or not I understated or overstated the fact?

A. I have not considered the matter.

Q. I will read to you from volume 4, page 2,933, folios 61 and 62 of the record in the Passaic Valley Sewerage Matter, in the suit instituted by the People of the State of New York against the State of New Jersey and the Passaic Valley Sewerage Commissioners. Mr. Michael Dunn, the city attorney of Paterson, New Jersey, who describes on that page the amount of work that he had had to do in protecting the city's interests from litigation by riparian owners who had been injured by the sewage discharges and the trade waste discharges, states:

"I have also had occasion to give considerable study to this subject in connection with the Passaic Valley Sewerage Commission," and then he proceeds to describe how intimately he had followed the work done by the Passaic Valley Sewerage Commissioners. I proceed to quote from his testimony:

Mr. Riker: Testimony is it?

Mr. O'Sullivan: Yes, he gave his statement before the
119 Harbor Line Board—I don't know whether he was under oath or not.

(Continuing:) "In this valley is represented one-third of the taxable ratables of the State of New Jersey. In this territory is represented one-third of the population of the whole State of New Jersey. The Passaic River is an open sewer and it has been an open sewer and in consequence we must find some relief." You agree with these statements, or do you take issue with those made by the city attorney of Paterson before the Harbor Line Board in December, 1908?

Mr. Riker: I object to the question on the ground that it is a matter that was not testified to on the direct examination, and is not cross-examination, and is directed to a statement of an attorney as to facts as to which this witness has already testified he has no knowledge.

Mr. O'Sullivan: The question is pressed for the reason that in computing the amount of trade waste to be contributed to the Passaic Valley trunk sewer, the element of population is an essential element in making estimates of calculations along that line.

Commissioner Maher: The objection will be noted.

A. I have no further comment to make in regard to pop-
120 ulation, but as regards the trade wastes, I may call attention to the fact that that matter has been previously explained by me as a subject which was specially investigated, and the population is only one of quite a number of elements considered in arriving at a conclusion concerning the capacity of the trunk sewer.

Q. And part of your duties as a member of the firm of Hering & Fuller, engaged for engineering work by the Passaic Valley Sewerage Commissioners in 1907, consist in making estimates of the sewage contributions of the various communities, did it not?

A. Yes, sir.

Q. And what did you estimate the per capita sewage contribution from the various communities?

A. I cannot tell you from memory what we did. I can explain briefly in this way, that we found out what was the the water supply in the different communities on the basis that the spent water supply, after it had been used in the different buildings, houses, stores and manufacturing establishments, would be the main element of the sewage flow. We considered the amount of ground water which would enter the sewers through joints in the existing sewers which were not tight in all cases. We gave some consideration to storm water flows in certain sections, and then in regard to trade wastes,
the particular point to which you are directing your in-
121 quiry, there was a study made by an assistant sent to each of the different industrial establishments in this Lower Passaic Valley. It is true that there is a good deal of water used by these different industrial establishments. It was recognized, however, that in the textile industry it is perfectly feasible and would be proper to have owners of the industrial establishments separate those wastes which would be markedly polluted, from those which are only slightly polluted. I mean by that, that the dyeing industry, either silk or wool, there is a large volume of water used in washing the fabric after it has been dyed, and the first or second washings or rinsings would take the bulk of the impurities; after that the water would be slightly tinged, and reaching ultimately a water which is practically pure. These relatively pure wash waters were assumed to be put into the river direct, and it was the conclusion on the detailed investigation of each industrial plant in this valley, that if ten per cent of the capacity of the sewer, or its ultimate size in respect to its ultimate population—that if ten per cent of that were devoted to this more concentrated trade waste, that would be an ample allowance. That is what was done in the
1908 and 1909 program, and I was one of a dozen men as-
122 sociated with my firm who went to some of those industrial establishments and certainly spent a good deal of time in collating the evidence and drawing the conclusion which I have summarized for you.

Q. Will you state who some of the other men associated with

the firm of Hering & Fuller were who made the investigations regarding the trade wastes and the sewage and made calculations on the per capita trade waste and sewage contributions by the various communities and manufacturing plants?

A. The two active assistants in charge of the work in the field were William B. Fuller, and George A. Johnson. They had under them quite a number of other assistants. I cannot recall the name of the young man who for several months devoted his time exclusively to going to these establishments.

Q. Was it Breitzke?

A. No; Breitzke was one of the assistants on that work, though.

Q. What part of the work did Mr. Theodore Horton perform, who is now the chief engineer of the State Department of He[illegible] of the State of New York; what part of the work did he perform?

A. Theodore Horton was the principal assistant of Hering & Fuller during the study of the Passaic Valley project in 1901
123 and again in 1903. He left our employ in the summer of 1906, to accept his present position.

Q. Was he not engaged on the designs and plans for the construction work chiefly?

A. If you mean plans in the sense of on which were based the estimates of 1901 and 1903, I think that is generally correct. He was not, however, identified in any way with the work in 1907-08, which was a period when there were prepared the plans serving as the basis of the contract made between the Passaic Valley Sewerage Commissioners and the different municipalities.

Q. Did you yourself, Mr. Fuller, interview any of the directors or managers of any of those manufacturing plants?

A. Yes, I did in a number of cases—not so many, but they were the larger ones, in the upper end of the valley.

Q. Did any of those in charge of these manufacturing plants that you interviewed, agree to make that separation between the more highly polluted trade wastes and the less polluted trade wastes that were to be discharged into the Passaic River?

Mr. Riker: The question is objected to as not cross examination and as immaterial and irrelevant.

124 Commissioner Maher: The objection will be noted.

A. I cannot say that there was any agreement in writing; I don't think there was. The question from the range of my own experience was limited in my discussions to the question of feasibility, not to the question of agreement to do it, or acquiescence in it. That is a matter which I have assumed will be taken up in due time, if it has not already been considered, by the commission with each of those manufacturing establishments.

Q. At any time between the years 1901 and the present month of June, 1919, have these manufacturers or owners or directors of these manufacturing plants, either written or orally or otherwise, agreed to make the separation between the more highly polluted trade wastes that were to go into the trunk sewer and the less polluted trade wastes that were to be discharged into the river, as far as you know?

Mr. Riker: Same objection as to the last question.
Commissioner Maher: The objection will be noted.

A. I am not informed on the matter at all.

Q. In making your calculations as to the contributions of
125 trade wastes from these plants, was that based entirely upon the water consumption as these figures were furnished to you by the water supply department?

A. You mean water supply departments of the particular establishment—industrial establishment, or is your question directed to the water supply departments of the municipalities and water companies? I can tell you briefly what we did do.

Q. I wish you would.

A. We found that it was necessary to make an inquiry as to the volume of water used at the larger establishments and to ascertain how much water was gotten from a variety of sources. By that I mean that not only is the city water supply, so to speak, used by some or many of those establishments, but there are independent supplies. For instance, at Paterson there is a dyers' pipe line which takes unfiltered water above the Great Falls in Paterson; that is independent of the water supplied by the city department. Then some of the establishments take water directly from the river; some of those local individual river supplies are filtered, some of them are not. Then there is a good deal of water taken from wells used in the dyeing establishments.

Q. Artesian wells?

126 A. So-called artesian wells, yes, sir. It is a fact that there is a good deal of water used in this lower Valley for manufacturing that does not come from the pressure pipe lines from which the general municipal supply is obtained. That was all taken into account, sir.

Q. Can you give me any approximation as to the relative ratios for these establishments, between the water that comes from the public water supplies and the water that is taken either from the river or from artesian wells?

A. I cannot give you any close figures from memory; I think there are sections where the so-called independent supply would exceed the volume of water furnished the municipalities.

Q. I call your attention now to stipulation number (2) in Complainants' Exhibit 135, in this suit:

"There will be absence of deposits objectionable to the Secretary of War of the United States in the New York Bay coming from the Passaic Valley Sewage." If the effluent stipulated for in Complainants' Exhibit 135 were discharged in Newark Bay, would there be like absence of deposits objectionable to the Secretary of War?

A. Yes.

Q. Earlier, I understood you, Mr. Fuller, to testify that
127 you had read the testimony given in this record, and I now ask you if you read the testimony of General Henry Martin Roberts, who from 1895 to 1901 was President of the Board of Engineers for Fortifications of the New York Harbor Line Board?

A. I looked over all of that testimony, but it is such a bulky proposition I cannot say that I read every line; I cannot recall every point made by the different witnesses, but I endeavored at the very outset this spring in my connection with this case, to become generally familiar with the testimony already taken. I know that General Roberts was a witness.

Q. For the defendants?

A. For the defendants.

Q. I seek to refresh your memory by quoting from volume 3, page 2377, folios 3469-3470; this question was put on cross-examination: "Q. So that from the effluent as stipulated in Complainant's Exhibit No. 135, you would expect sufficient matter to be deposited so that it would to some extent interfere with navigation?"

A. In Newark Bay quite seriously.

Q. Have you made an approximate estimate of what the amount of deposit would be likely to be?

A. (His answer is a long one; after giving a basis for his estimates and matters of that kind, I quote the remaining part of his answer—"which would amount at least to 1,200 cubic yards of solid deposit per day, or during the year 400,000 cubic yards of deposit."

Q. Do you agree with that estimate of General Roberts as
128 to the amount of deposit that would occur in Newark Bay from the effluent as stipulated for in Complainant's Exhibit No. 135?

Mr. Riker: The question is objected to on the same ground as the recent previous questions have been objected to.

Commissioner Maher: The objection will be noted.

A. I do not agree with General Roberts, and I point out here, for the sake of explicitness, the General was evidently referring to deposits which would arise in connection with unsettled sewage; whereas, in accordance with the provisions of this stipulation, it is distinctly set forth that sedimentation basins would be provided, in which there would be removed from the sewage all matters capable of being responsive to the laws of subsidence, and hence there would be no deposits at all as a practical proposition, arising from the effluent as it will leave the sedimentation basins. And I make that still further explicit by saying, it makes no difference whether that effluent would go into either Newark Bay or New York Bay, so far as absence of deposits is concerned. I make one other comment: I take this stipulation (2) in regard to "Absence of deposits objectionable to
129 the Secretary of War of the United States", to refer to deposits which build up and interfere with navigation, as I understand the acts of Congress applicable to such situation.

Q. Do you expect any deposits to any considerable extent will be left in the New York Bay as the result of the discharge of this stipulated effluent as set forth in Complainants' Exhibit 135?

A. No, I expect practically no deposits at all would arise from the effluent leaving the sedimentation basins.

Q. Directing your attention to the stipulation numbered (3):

"There will be absence in the New York Bay and its vicinity of odors due to the putrefaction of organic matters contained in the Passaic Valley sewage thus discharged." I ask you, Mr. Fuller, whether there would be absence of these odors if that effluent were discharged into Newark Bay?

Mr. Riker: Same objection.
Commissioner Maher: The objection will be noted.

A. There will be absence of odors in Newark Bay, also in New York Bay, on the basis of treatment provided as stipulated
130 and as I have described.

Q. Directing your attention to stipulation (4), Mr. Fuller, which I quote: "There will be a practical absence on the surface of New York Bay of any grease or color due to the discharge of the Passaic Valley Sewage at the dispersion area or elsewhere," I ask you if there would be a like practical absence on the surface of Newark Bay, if the effluent stipulated for in Complainants' Exhibit 135, were discharged in Newark Bay instead of New York Bay?

Mr. Riker: Same objection.
Commissioner Maher: The objection will be noted.

A. I am of the opinion that the results would not be as satisfactory in Newark Bay as in New York Bay with respect to the absence on the surface of the water of grease or color, and I base that view upon the less depth and small velocities of bay water in the Newark Bay as compared with the New York Bay.

Q. How does the velocity and depth of water remove grease from the surface of water or diminish color due to the discharge of an effluent of sewage?

A. The greater depth permits mixing and the velocity brings about a great volume for diluting purposes to lessen the appearance at the surface.

Q. Does grease mix with water?
131 A. I will explain my view in regard to the grease question. There are perhaps three classes of grease substances which will enter a sewer: One of those groups would be particles of a size which would congeal to a size so that they would be removed in the sedimentation basins. That removal is effected in part by the actual deposit of the coarse grease particles, and it is in part effected by a grease which will arise and form little grease balls, arising to the surface, and they would be held back by scum boards. I find in my experience that tanks will remove thirty to fifty per cent of the greasy substance. Of the remainder, some of the grease particles are in what you might call practically true solution; others are very fine particles in size. The greater mixing which you can get, the better will be the appearance at the surface as regards the freedom from these little tiny particles of grease or the soluble grease; so if you had a depth of water over the dispersion area of twenty feet as compared with fifty feet, I am firmly of the opinion that you would obtain better results with a fifty foot depth than you would with a twenty foot depth.

The other phase of the matter is that of the dilution, and while I have not prepared myself and cannot state from memory what
132 the velocities are in Newark Bay, I am making my answer under the impression that you do not get the velocities and volumes of diluting water in Newark Bay that you would in New York Bay. In brief terms, if you get the dilution of this very low clarified sewage of ten fold, it is not reasonable to expect that the appearance of the surface would be as satisfactory as if you get a dilution of fifty to one hundred fold, such as I believe will be the case very firmly, with the dispersion of this clarified sewage from the Passaic Valley project as I have described, through this particular dispersion area, with the very efficient nozzles which are being installed there.

Q. Does the depth of water or the velocity of the currents interfere with the fact that grease will float on the surface of the water no matter what the depth of that water may be?

A. It does within the limits of what I have described in brief, and I should here insert, perhaps, one phase that I have not alluded to in my last preceding answer and that is that the densities of the water over the dispersion area is a factor. But the point that I want to make plain in response to your last question is, that in these basins there will be removed a large proportion of the
133 grease; of the remainder there will be an opportunity in a fifty foot depth of water to mix it so thoroughly that it will not reach the surface, and that is true relatively to the extent that I believe you will note more of a tendency with a twenty foot depth than a fifty foot depth of water.

Q. Then if I understand you right, Mr. Fuller, if a greasy effluent is discharged at a great depth, the grease will not reach the surface of that body of water, is that correct?

A. It isn't absolutely so. This stipulation (4) provides practical absence. The point that I am carrying in mind, and perhaps am not making plain is, that if you dilute this clarified effluent containing grease with one hundred times its volume of Bay water, then I maintained and am clearly of the opinion that there will not be any violation of this practical absence called for by stipulation (4). I tried to bring out that diluting effect in that sense.

Q. I note that you lay emphasis on the term, "Practical" as applied to "absence." May I ask you to define what you mean by the term "practical absence" of any grease or color on the surface of New York Bay water?

Mr. Riker: Same objection as I made to the last question,
134 and the further objection that the interpretation of the instrument is not committed to expert witnesses nor a subject of expert testimony.

Mr. O'Sullivan: The question is pressed for the reason that the interpretation is not requested in the question as to the generic value of the terms, but as to what this witness as a sanitary engineer understands when he is discussing the effluent that will not contribute grease or color and in which they will be practically absent.

Commissioner Maher: The objection will be noted.

Mr. Riker: The further objection that from the statement of counsel it appears now that the answer to the question must be irrelevant and immaterial.

Commissioner Maher: The further objection will be noted.

A. By practical absence of grease, I understand that there will be a condition on the surface of the water in New York Bay such that there could be no reasonable exception taken to the situation. I mean by that, that it is a fact that there are some oily and greasy substances in solution that cannot be removed completely, and New York
135 Bay today contains a large amount of sleek which in quiet weather is noticeable in the various sections of the Bay. My idea is that a practical absence implies that there will not be anything expected which is impossible of accomplishment. You cannot get complete removal, but if you could get a removal of the non-settling grease which would result with a dilution of fifty to one hundred fold of Bay water with that grease, you would have nothing that would be objectionable to the citizens or user of boat craft as they ply on those waters.

Q. In your studies of Complainants' Exhibit 135, and particularly of that fourth stipulation, whom do you regard as the authority to determine whether or not there would be practical absence of grease or color on the surface of the New York Bay water?

Mr. Riker: Same objection as the last.

Commissioner Maher: The objection will be noted.

A. In reply to that question, I will call attention to what I have studied with care, in response to that inquiry, and that is the paragraph Third of this Exhibit, which says:

"The said Passaic Valley Sewerage Commissioners further
136 agree with the United States that so long as said sewer system or part thereof, is operated, the United States shall have through such representatives as may be designated by the Secretary of War at any time for such purpose, full opportunity to inspect the condition and working of the sewer system with a view to determining whether this contract is being in all respects performed and that the said Passaic Valley Sewerage Commissioners will render such expert or other assistance as the United States may desire in the course and in the aid of such inspection and determination."

Q. Then you would expect some agent of the Secretary of War to pass upon these matters and to enforce compliance, if necessary?

Mr. Riker: Same objection as to the last question.

Commissioner Maher: The objection will be noted.

A. I think that is a reasonable deduction from the paragraph Third which I have just read. I do not wish to have it inferred, however, that I have assumed that there will not be intelligent and faithful operation of this sewerage system and its appurtenant works on the part of the representatives of the Passaic Valley Sewerage Commissioners. On the contrary, I have specifically assumed that

the Commissioners will have efficient and faithful operation of their works.

Q. But in case that the works were inefficiently operated, and that the stipulations that we had read were violated, it would be
137 incumbent, as you understand it, for some agency of the Secretary of War to direct attention to the violation of the stipulation and to seek to enforce its terms, is that correct?

Mr. Riker: Same objection as to the last question.
Commissioner Maher: The objection will be noted.

A. I read this paragraph Third as being permissive rather than mandatory, but it certainly provides a channel for the Federal Government to take jurisdiction in the event of need.

Q. And what you have said now with regard to the fourth stipulation applies to the others, does it not?

A. Yes.

Q. You were interested and aided in the formulation of these stipulations, did you not, Mr. Fuller?

A. Yes, these stipulations are approximately the same as appears in Defendants' Exhibit 5, being the communication addressed to the Passaic Valley Sewerage Commissioners, under date of March 25, 1909, and signed by Mr. Hering, Mr. Harrison, and myself. There are some addenda, however, in the stipulation some additional clauses, but so far as these first four clauses that have been put in your questions to me are concerned, they do appear in this defendants' Exhibit 5.

138 Q. At the time you aided in the formulation of the stipulations that are contained in Complainants' Exhibit 135, did you know at that time despite these stipulations the United States Government had no control over sewage disposal unless by deposits it interfered with navigable capacity of the waters of the United States?

Mr. Riker: Same objection as to the last question.
Commissioner Maher: The objection will be noted.

A. That is true, if you are inquiring as to my knowledge of what the Federal Government would do in pursuance of legislation passed by Congress, but I am of the opinion that this stipulation refers to a situation which would allow the Federal Government to step in on the basis of specific performance of a specific stipulation as herein described.

Q. That stipulation, Mr. Fuller, was executed about April 14, 1910, was it not?

A. Yes, sir.

Q. When did you publish your book on Sewage Disposal?

A. May, 1912.

Q. Have you got a copy of your book with you?

A. Yes, sir.

Q. Will you turn to page 183, Mr. Fuller? I quote from
139 page 183 of a work on Sewage Disposal, by George W. Fuller:

"The United States Government at present has no control over sewage disposal except in so far as sewage deposit relates to the shoaling of navigable bodies of water. (See Act approved March 3, 1899 in the Supplement to the Revised Statutes of the United States, Vol. 2, page 994.)"

Did I read that correctly?

A. Yes, sir.

Q. You had that knowledge at the time that these stipulations were formulated?

Mr. Riker: The question is objected to on the ground that it deals with an expression of opinion by a layman as to the legal effect of statutes of the United States, and is therefore immaterial and irrelevant.

Commissioner Maher: The objection will be noted.

Mr. O'Sullivan: The question is pressed for the reason that no matter what the source of this sanitary engineer's knowledge was, if it influenced his opinions and views and aided in the formation of stipulations that he himself regarded as unenforceable, it is perfectly admissible to show that fact by way of cross-examination.

Mr. Riker: Now the question is objected to on the ground
140 that it appears from counsel's statement that he concludes that the opinion expressed in the book is not based solely upon statutes; whereas, the stipulation is a matter of agreement, irrespective of and additional to the statutory provisions.

Commissioner Maher: The objections will be noted.

A. I really don't know. This book was prepared in the ten or twelve months preceding the date given in the preface, which is April 1912. I do not really recall whether that information was possessed by me or not, but in any event, it makes no difference. If your inquiry is directed toward the possibility of formulating stipulations that would not be under the jurisdiction of the Federal Government as to performance under general acts of Congress, it is perfectly feasible for the Federal Government to proceed to investigate these matters, as I had done for the Federal Government in a number of instances. For instance, I was a member of a commission appointed by the United States Senate in formulating the program for the filters of the City of Washington's water supply. I don't know that we proceeded under any general act of Congress. I was asso-
ciated in 1906 in an investigation for the American mem-
141 bers of the International Waterways Commission with respect to pollution in the Chicago District and correction, other than by a branch of the Chicago Drainage Canal. I certainly had no intent in 1909 of getting behind any failure of performance on the part of the Federal Government through absence of jurisdiction; absolutely none.

Q. In Defendants' Exhibit No. 5, which I directed your attention to yesterday, Mr. Fuller, I read the second paragraph:

"This statement is prepared for the purpose of securing cooperative action to decide the details of this method in a manner satis-

factory to the parties in the pending suit between the States of New Jersey and New York and the United States in accordance with the understanding arrived at during the conference held in the office of Attorney General O'Malley in New York City on March 11, 1909.'

I asked who was Attorney General O'Mailey, and what state was he Attorney General of?

A. He was Attorney General of the State of New York.

Q. Can you state why the Attorney General of the State of New York was not a party to this stipulation?

A. No.

Q. That was being formulated for the purpose of securing his co-operation?

A. I assumed that he would be a party to the stipulation.

Q. Would the Attorney General of the State of New York have power to enforce the terms of this stipulation, Complainants'
142 Exhibit No. 135?

Mr. Riker: The question is objected to on the ground that it calls for a legal opinion from a layman.

Commissioner Maher: The objection will be noted.

A. I do not know.

Q. Is it your knowledge of the fact that the War Department would be unable to enforce the terms of that stipulation unless it interfered with the navigable capacity of waters of New York Bay?

Mr. Riker: I object to the question on the ground that the witness has not said that the stipulation is unenforceable, and as a matter of fact it would call for a legal opinion, which is contrary to the fact.

Commissioner Maher: The objection will be noted.

Mr. O'Sullivan: The question is pressed for the reason that this witness was instrumental from 1909 in proposing the basis for this stipulation, and states in a communication to the Passaic Valley Sewerage Commissioners which was put in evidence in this suit by defendants' counsel and is Defendants' Exhibit No. 5, that the
143 statement in relation to the details was to be arrived at by co-operation, and afterwards the Attorney General of the State of New York, whom I represent, was not invited to be a party to the stipulation and that this witness has further stated that he realized that the terms would not be enforceable unless interfering with the navigable capacity of the Harbor waters of New York.

Mr. Riker: The statement of counsel is contradicted on the ground that it is contrary to the facts which appear in the evidence, that there is no statement by this witness that the stipulations are unenforceable.

Commissioner Maher: The objection will be noted.

A. No, and let me say further, for the sake of clarity, that this second paragraph in Defendants' Exhibit 5, in which it appears that the statement signed by myself and associates is "prepared for the purpose of securing co-operative action to decide the details of this method, in a manner satisfactory to the parties in the pending suit,"

that statement appears there because I and my associates did not believe that it was necessary to install the treatment devices to the extent set forth in the stipulation in order to bring about an in-
144 offensive and satisfactory dispersion of sewage in New York Bay. So far as this intimation appears, when the question is put to me, that there was any thought in my mind of getting behind the failure of the Federal Government or of the State of New York or any party having jurisdiction, or having a right to investigate the performance of this Passaic Valley Sewerage Commission project in any way, that was not in my mind at that time, or at any time since that date, or before it. I believe in the fullest light being thrown on the credibility of performance of the sewage treatment works of the Passaic Valley Sewerage Commissioners. I believe they will stand the light of day, in the most thorough searching examination that can be given them. And I think that the project, in the view of myself at least, is strongly to the end that there should be no resistance on the part of any reasonable examination being made to test the adequacy of performance.

Q. This statement you embodied in Defendants' Exhibit No. 5 was for the purpose of securing co-operative action at a conference to be held in the office of the Attorney General of the State of New York. Do you recall whether he did participate after you submitted the outline scheme that is embodied in Complainants' Exhibit 135?

A. No.

145 Q. Did you have before you the recommendation made by Colonel Black to the Secretary of War that was to form the basis of these stipulations?

A. I certainly studied this at considerable length ten years ago. I cannot tell whether I had them at this conference in Attorney General O'Malley's office or not, but I had studied them in years gone by, not recently.

Q. In reading the testimony in this record, Mr. Fuller, did you read the evidence or testimony put in by Professor Earl B. Phelps on behalf of these complainants?

A. Yes, I read it over, portions of it, very very carefully.

Q. Who is Professor Earl B. Phelps; do you know him personally?

A. Yes.

Q. Who is Professor Earl B. Phelps?

A. He is a former assistant Professor of the Massachusetts Institute of Technology; he is a graduate of that Institution, spent several years with the Massachusetts State Board of Health, and later had charge of a small testing station for investigating the means of purifying sewage, at the Massachusetts Institute of Technology. He made some investigations with Colonel Black of New York Harbor waters in behalf of the Boarl of Estimate and Apportion-
146 ment of New York City. For some years he was attached to the office of the Surgeon General of the United States Public Health Service, and has been connected with Federal investigations of stream pollution, particularly in the Ohio River, and Potomac River, to some extent; I think not in this State; and he has been

one of the engineers advising the International Joint Commission, to which was referenced the program of procedure for controlling the pollution of inter-boundary waters between this country and Canada in pursuance of the treaty provisions between the United States and Great Britain, I think in 1909. I understand that Professor Phelps has recently left the Government's employ.

Q. He was at the head of the Hygienic Laboratory in Washington, was he?

A. I don't think he was at the head of the laboratory; I thought he was the chemist attached to that branch of the service that devoted particular attention to stream pollution questions.

Q. He spent many months in conjunction with Colonel William M. Black in investigating the sewage capacity of New York Harbor waters, did he not?

A. I presume so.

Q. Did you read the result or report of his work that he did with Colonel Black?

A. Yes, when it came out I studied it with much care and
147 looked at it from time to time since.

Q. Did you understand that Colonel Black had made recommendations which were to form the basis of this stipulation known as Complainant's Exhibit 135?

Mr. Riker: The question is objected to on the same ground as the recent questions have been objected to.

Commissioner Maher: The objection will be noted.

A. The Secretary of War, through the Commanding General of the Department of the East, to which office Colonel Black was then attached as chief engineer officer, did make request for Colonel Black to make a report on the matter, and in that report was an expression of views that bore on this question of the degree of treatment which should be given to the Passaic Valley sewage before it was discharged into New York Bay.

I shall make it plain that there were a great many conferences in those days in Colonel Black's office, my office and the office of Attorney General O'Malley, and there was an effort made to bring into the same plan the views of many minds. I have no desire to eliminate or ignore any of Colonel Black's suggestions. I don't think any one man was responsible for all of these thoughts that appear
148 in the stipulation which was a composite effort.

Q. Did Colonel Black to your knowledge make any recommendations in relation to a putrescibility test, or any matters in regard to diminishing the putrescibility of the effluent to be discharged from the sewage disposal plant on the Newark Meadows of the Passaic Valley Sewerage Commissioners?

Mr. Riker: Same objection.

Commissioner Maher: The objection will be noted.

A. That is a subject upon which he made a report. I am not quite sure whether it pertains to the Passaic Valley or some other;

perhaps the Bronx Valley project, because it is a fact that the degree of removal of organic matter, that is, putrescible matter from sewage, is a subject that he made a report upon and that subject was discussed with him. I cannot remember during an interval of ten years just all of the details of those conferences, but I certainly did discuss the general subject of that matter with him.

Q. I wish to see if I cannot stimulate your memory a little in that regard, Mr. Fuller, by quoting from volume three of the record in this case, pages 2750-2751, folios 4054, and 4055, Professor Earl B. Phelps, under cross-examination by Mr. Riker, the following
149 questions and answers are on the pages that I have just cited from:

"Q. You understand that the stipulation which is Complainants' Exhibit No. 135, was adopted by the Government representatives, the United States Government representatives, including Mr. Black, or Colonel Black?

A. Yes.

Q. You understand that in his opinion the result will be the result guaranteed, do you?

A. No.

Q. And you do not understand that he believed that the result would be reached by the processes that are enumerated in that stipulation?

A. I know that Colonel Black's personal opinion is that that result will not be reached by these proposed works.

Q. And you know that, do you?

A. Yes.

Q. And nevertheless he was responsible. Do you know he was responsible for this stipulation?

A. He was not supremely responsible, nor were the specifications that were finally adopted his original recommendations to the Secretary of War.

Q. Well, didn't he approve of them and recommend them?

A. Not in the form in which they were finally adopted.

149*a* Q. You are sure of that, are you?

A. Yes, sir.

Q. What additional specifications were there in Colonel Black's recommendation which is not in this stipulation?

A. His original recommendation contained a clause in addition to those that were finally accepted, that the putrescibility of the sewage measured by certain specific standards should be reduced to a stated number,—I have forgotten the exact figure, but my recollection is 75% before discharge.

Q. It should be reduced to 75%?

A. Yes."

Does that refresh your memory with regard to that putrescibility recommendation by Colonel Black with regard to the formu-
150 lations of these stipulations?

A. I think that is substantially in line with what I discussed with Colonel Black. I should state it in this way, that he

was contending for the removal of organic matter to the extent of 25%—I am not quite plain whether that as read indicates a removal of 75 per cent; that is not true. It is a reduction of the total organic matter from one hundred per cent in the raw sewage to seventy-five per cent appearing in the effluent—that is the removal—the reduction was only twenty-five per cent. I don't think there is any difference materially in the figure which Colonel was contending for and that which will actually be produced by the treatment devices actually being built by the Passaic Valley Sewerage Commissioners. I believe that that size basin was another way of meeting the view of Colonel Black.

Q. Did Colonel Black in his recommendations furnish, as Professor Phelps testified, standards for the measurement of the fact as to whether or not that percentage of putrescibility was reduced?

A. I cannot tell; I haven't read that report to the Secretary of War for nearly ten years.

Q. Do you recall, Mr. Fuller, why they were disregarded in the formulation of these stipulations in Complainants' Exhibit
151 135, which you aided in formulating?

Mr. Riker: The question is objected to on the ground that it is not cross-examination, and is immaterial and irrelevant.

Commissioner Maher: The objection will be noted.

A. I am not able to throw full light on that inquiry. It is something that developed during the year intervening between this Defendants' Exhibit 5, and the appearance of this stipulation, which was nearly a year later. During that interval there were a good many discussions, and the upshot of that was that instead of naming a percentage removal by a method which Professor Phelps had suggested, I think, of getting the incubation test—a method that was not at all known outside of one or two laboratories, it was considered by myself and others, speaking for the State of New Jersey, and the Passaic Valley Sewerage Commissioners, that the construction of basins of a certain size as to dimensions, detention period and velocities, was a more tangible, definite proposition.

Q. My question was directed, Mr. Fuller, to the fact that methods for determining compliance with these stipulations with regard to the putrescibility of the effluent, were eliminated, and I ask
152 you if you did not participate in the various conferences prior to the completion of Complainants' Exhibit 135?

A. I certainly did attend a good many of the conferences, not all of them.

Q. And I now ask you why tests of any kind were eliminated in order to determine the character of that effluent?

Mr. Riker: Same objection.

Commissioner Maher: The objection will be noted.

A. I tried to make it plain in my preceding answer, that the reduction in putrescibility involved methods of procedure in the laboratory that were not generally known. I didn't know about them.

Q. Are they in use now?

A. I don't think so, generally; they may be in use, in some places. The difficulty in taking a project of this magnitude and trying to develop a yardstick for measuring the credibility of its performance through a method that is not generally known, was objected to. I objected to it then and I object to it now. There can be no question about the good faith and reliability of performance within reasonable limits, if you set down the dimensions of the basin and the detention period of the velocity. That certainly was a viewpoint of the spokesman for New Jersey. I thought at that time it was sound,
153 and I think so now. If it is thought at all that it was a means of circumventing a credible, adequate performance, certainly nothing of that sort was in my mind, nor is there any such thought in my mind now.

Q. You have made water examinations yourself, have you not?

A. Yes, I have had charge for nine years of leading laboratories in this country, at Lawrence, Louisville, and Cincinnati. I am not a very expert analyst myself. I have not followed that line of work since 1897.

Q. How would you determine in a given sample of either water or sewage effluent, the amount of organic matter contained either in the water or in the sewage effluent?

Mr. Riker: Same objection as to the last question objected to.

Commissioner Maher: The objection will be noted.

A. I am perhaps a little old-fashioned, but I should have to stick to my own experience, and that is, the determination of the organic nitrogen or albuminoid ammonia obtained by distilling the water with permanganate; and I would also use the oxygen consumed test, which means the amount of organic matter would be measured by the lessening of the oxygen which would be given off from
154 the known volume of permanganate of potash in a boiling solution. Those are the methods which have been in vogue in this country and in Europe for a period of thirty-five to fifty years. And that is the method which has been used by all investigators on large sewage treatment investigations or tests, either of plants in practice or test plants. Let me say that the putrescible test has been used by a good many laboratories in connection with filtration processes, to see whether the effluent would putrefy upon standing in the laboratory in a glass bottle. It is a different matter, however, when you try to apply the putrescibility test to a sewage clarification process.

Q. And if you were in charge of the Passaic Valley sewage disposal plant on the Newark Meadow, you would use those tests in preference to others, would you not?

A. I would use those tests as the main guide or reliance. I certainly would not shut my eyes to efforts to acquire more knowledge through any methods found elsewhere to be helpful.

Q. And no such tests as to the efficiency of the plant are embodied in these stipulations are there?

A. No.

Q. I direct your attention to the fifth stipulation in Complainants' Exhibit 135:

155 "There will be no injury to the public health which will be occasioned by the discharge from the said sewer into the Bay of New York in the manner proposed and no public or private nuisance will be created thereby."

I now ask you if there would be any injury to the public health occasioned by the discharge from the Passaic Valley sewage disposal plant into Newark Bay?

A. No, I think not.

Q. I direct your attention to the sixth stipulation, which reads:

"The absence of injurious effect from said sewage discharge, upon the property of the United States situated in the Harbor of New York."

If that discharge were made in Newark Bay, would there also be absence of injurious effect upon the property of the United States situated in the Harbor of New York?

A. There would be absence, yes.

Q. I direct your attention to the seventh, and last of the stipulations in Complainants' Exhibit 135, which reads:

"The absence of reduction in the dissolved oxygen contents of the waters of New York Bay, resulting from the discharge of Passaic Valley Sewage, to such an extent as to interfere with major fish life."

Would that stipulation be equally true of a discharge into Newark Bay?

A. No, I don't think it would be equally true, so far as the fish in Newark Bay are concerned.

156 Q. Why?

A. Because there is a less volume of diluting water. I haven't considered the adequacy of that volume for this Passaic Valley sewage flow, but it is my recollection that taking into account reaeration, it would be a pretty credible performance in Newark Bay. I cannot say it would be a similar reduction oxygen as there would be in New York Bay. I want to make this plain: That a given number of units of organic matter, or the sewage clarified as completely as it will be by the Passaic Valley Sewage treatment devices, will utilize oxygen to substantially the same extent, other things being equal, whether in Newark Bay or New York Bay.

Q. Mr. Fuller, as I understand your testimony, the plant described in Complainants' Exhibit 135, will, without any additions or modifications, yield the effluent that is described and stipulated for?

Mr. Riker: The question is objected to on the ground that the stipulation doesn't describe the effluent, but describes the result of the effluent when discharged into the waters of New York Bay at the depth and under the conditions provided for in the stipulation.

Commissioner Maher: The objection will be noted.

157 A. I think the devices set forth in the stipulation will produce that result. I am carrying in mind that the dispersion area will have the benefit of these dispersion nozzles that I have spoken about at some length, and they are an improvement which should by no means be left out of view in considering the performance of this project.

Q. Then as I understand you, the effluent or its stipulated results, which you distinguish from the effluent itself, will be the joint product of a sewage disposal plant and the waters of New York Bay?

A. That is the result, in the waters of New York Bay, will show the effect of the diluting and dispersion, and they will also show the effect of the clarification and treatment and sedimentation and other devices; that is a fact.

Q. What percentage of the work of purification would you expect the waters of New York Bay to perform?

A. I hesitate to state the percentage. The basins and screens will remove all that is reasonable to expect to be removed by arrangements of that sort. I cannot separate it in my mind very clearly, the difference between total performance and the performance by the basins and screens.

158 Q. If the waters of New York Bay are not expected to do a large percentage of the digesting work on the organic matter in the sewage effluent to be discharged from the Passaic Valley sewage disposal plant, why is there objection to discharging that effluent into Newark Bay?

Mr. Riker: The question is objected to on the ground that the hypothesis contained in it is not in accordance with any testimony of this witness, and is not in accordance with the fact.

Commissioner Maher: The objection will be noted.

A. I have never considered the disposal of sewage in the Newark Bay at all. You are opening up an inquiry into which I have never directed my attention. It is a fact that the soluble organic matter coming from the effluent of the Passaic Valley sewage works would make some demands on the oxygen content of the waters of New York Bay. I am not trying to imply the absence of any demand by this Passaic Valley sewage on the digestive capacity of New York waters. I don't think I am stubborn in that respect. I simply don't know what the facts are concerning Newark Bay.

Q. How does the oxygen content in Newark Bay compare with that of New York Bay?

159 A. I am really not well informed on that. I know that the waters of Newark Bay are reaerated and have, perhaps, rather more oxygen content than one would naturally expect, but I cannot give you any close comparison without preparation. I would have to speak now from memory.

Q. Can you mention any part of New York Bay, the Upper Bay, where the oxygen content is as high as it is in the Kill von Kull, which is the outlet from Newark Bay into the New York Upper Bay?

A. I should think, speaking from memory, that the Narrows and

at Robbins Reef light it would be substantially as high as at Kill von Kull. I have not the precise figures in mind on that; I know that these figures vary widely, depending upon whether the samples are taken on a flood tide or an ebb tide, and on a variety of factors. It is a great big proposition to talk about.

Q. Talking about ebb and flood tides, Mr. Fuller, what percentage of the water that goes out on the ebb returns on the flood into the Upper Bay of New York?

Mr. Riker: The question is objected to on the ground that it is not cross-examination, and therefore immaterial and irrelevant, and is not permitted under the order of March 10, 1919.

Commissioner Maher: The objection will be noted.

160 A. I will have to look up a lot of notes before I can answer that. I cannot tell you off hand; if you are testing my memory on that, I cannot give it to you from memory. I have studied those matters, though.

Q. I will quote from witnesses produced and who testified for the defendants. I quote from volume 3, page 2374, folio 3465: General Henry Martyn Robert, a witness produced by the defendants:

"Q. What percentage of the water that leaves the Upper Bay on the ebb returns on the flood into the Upper Bay and into the East River and the Hudson River?

A. I think somewhere about ninety per cent approximately."

Do you find that in the record, Mr. Fuller?

A. Yes, sir.

Q. Does that refresh your memory in any way as to the percentage of the polluted water that has gone out on the ebb and returns on the flood?

A. No, I would have to get my various data together to make a response to your question. I can do it later, but I cannot do it at the moment.

Q. Isn't that an important factor in estimating the digestive capacity of a body of water as to the degree of its pollution, as to the measure of its refreshment, and as to its oxygen content?

A. It is one element, but it is necessary to view that from these standards, that there is entering the Upper Bay of New York
161 pure fresh sea water. Now it is a fact that some of the water has been in the Upper Bay before; perhaps some of it has been in the lower Bay, and it is not a pure ocean water as it moves up through the Narrows; but this is the point that I want to make plain: that you must recognize that there is pure clean sea water with a full oxygen content, coming from the ocean, and this fact that as you test the incoming waters,—the incoming tide, flood tide, coming up through the Narrows, you have got to bear in mind that the movement backward and forward through the Lower Bay and Upper Bay, gives an opportunity for the sewage to act on the oxygen of the water for a longer period of time; but it does not mean that there is to be excluded the oxygen content of full pure sea water.

Q. What is the highest percentage of pure sea water that comes in on any flood?

A. I cannot tell you that from memory. I can prepare on these things if it is desired to open up these subjects that I have not testified to on direct examination.

Q. Does it ever at any time exceed twenty-five per cent of the incoming water on the flood?

A. I don't know, but I will be guided by the facts whatever they are.

Q. Have you studied the testimony given by Mr. H. de B.
162 Parsons, who made a special investigation along these lines with a salinometer and other methods of testing, and covering a long period of time, to determine these facts?

A. Yes, I studied that pretty carefully in the early part of April of this year. It is too complicated a matter for me to carry in mind as to detail of figures.

Q. You stated yesterday in your direct testimony that you had consulted some of the documents in your office in regard to this case to refresh your memory. Did you have occasion to study a report made by Hering & Fuller to the Passaic Valley Sewerage Commissioners dated December 31, 1907?

A. I looked at that a number of times particularly to get at the volumes and other data.

Q. Have you got a copy of that report with you now?

A. No, I have not.

Q. In what condition did you expect the sewage transported in the Passaic Valley trunk sewer to reach the disposal works on the Newark Meadows?

A. In that respect?

Q. With regard to its septicity.

A. During the colder months of the year I have always had in mind that it would not be septic, but during the warmer
163 weather of the year, the sewage which would flow from Paterson and Passaic would be very likely devoid of dissolved oxygen. Then you have to consider what would be the effect of the large city of Newark quite close to the pumping station—what effect that would have in overcoming the factor of that septicity.

I have regarded the sewage as one which as it would reach the pumping station on Newark Meadows would not materially differ, for instance, from the sewage that would reach the Deer Island outlet from the North Metropolitan sewage system of Massachusetts. That, by the way, I should make plain, is the view which I have had for some years and now hold, in the absence of aeration. I testified in my direct examination concerning aeration. That is not a feature which sprung up in response to this specific order of the Court dated March 10, 1919, but has been talked over from time to time for a good many years. It very likely would not be used, in my opinion, at all in some seasons, but I am now making plain the point that the septicity can be prevented entirely by the use of aeration.

Q. Do you recall that Professor Olin H. Landreth was the first

to recommend to the sanitary district of Chicago aeration in order to arrest or delay septicity in the sewage discharge into the canal?

Mr. Riker: The question is objected to on the ground that it is immaterial and irrelevant, and not cross-examination.

164 Commissioner Maher: The objection will be noted.

A. No, I did not know that. I testified in the so-called Federal suit in behalf of the Chicago Sanitary District to the effect that aeration should be provided for use when required in connection with intercepters. Professor Landreth was on the opposite side; he was present when I was cross-examined, I know, but I cannot tell you whether he proposed that at an earlier date to the Chicago authorities or not.

Q. That was in a suit instituted by the Federal Government against the State of Illinois, was it not?

A. Yes.

Q. And in the prior suit between Missouri and Illinois, you testified on the side of Missouri, did you not?

A. Yes.

Q. In your suggestion for aeration to arrest the putrefactive changes in the Passaic Valley sewage, did you contemplate using cold or hot air?

A. The air that you get from the atmosphere adjacent to the blower; it would vary with the season; it would be naturally used in the summer time only, and would be warm air.

165 Q. Did you ever make that suggestion before you made it in this room here, Mr. Fuller, to the Passaic Valley Sewerage Commissioners or their counsel?

A. Oh, yes, I discussed that with the officers of the Passaic Valley Sewerage Commissioners a number of times during the last ten years. I also put it into my report to the Metropolitan Sewerage Commission of New York in 1913, when I was reporting upon the so-called ocean outlet, for the diversion and disposal portion of the sewage of the city of New York.

Q. Don't you think now that that is the most feasible way of disposing of the entire sewage and trade waste of this great Metropoliton District, by a trunk tunnel sewer to the ocean?

Mr. Riker: The question is objected to as immaterial and irrelevant, and not cross-examination.

Commissioner Maher: The objection will be noted.

A. You mean New York and New Jersey?

Q. Yes.

A. Well, when the population exceeds fifteen or twenty millions, it certainly will have to be considered. Prior to the time when the total population is in the vicinity of those figures which I

166 give, it becomes a question of what is the most practical way, in view of all circumstances, to dispose of the sewage, and I believe that it should be taken up by sections. I want to make it very plain that I am in full sympathy with the effort to dispose of the sewage of this district so it will not create a nuisance, and I have

been rather opposed to an ocean outlet, on the theory that while ultimately I expect the time will come when it will be needed, the question of business aspects, the way of getting funds, leads me, to favor a proposition which would be capable of installation piecemeal. I am one of those engineers that favor taking the New York Harbor by sections and studying what is best for each section, and I am not inclined to favor the ocean outlet, so long as there remains this large margin of digestive capacity, if sludge would be removed and sewage solids eliminated to anything like the extent as will result from the Passaic Valley sewage treatment processes.

Q. Is your objection chiefly financial?

Mr. Riker: Same objection.

Commissioner Maher: The objection will be noted.

Q. Is that why you recommend these palliative measures which would exhaust thoroughly the digestive capacity of the Harbor before applying the more appropriate remedy for the relief of the entire Metropolitan District?

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Mr. Riker: The question is objected to on the grounds already stated in the last objection to counsel's question, and on the further ground that he has injected into the question statements of fact which are not justified by any evidence or any facts in the case.

Commissioner Maher: The objection will be noted.

Mr. Riker: I have special reference in that objection to the use of the word "palliative," and more complete and other qualifying adjectives as to conditions which counsel assume may exist.

Commissioner Maher: The further objection of counsel will be noted.

A. I have given a good deal of consideration to financial questions, because I have a keen appreciation of the fact that American municipalities have need for spending money in a great many different ways, and I do not believe that the situation here in this district as regards sewage disposal is one that calls by any means for an ocean outlet for some time to come. There is the administrative aspect as well as the financial. I haven't preconceived or stubborn mule views as to what can be actually put forward towards bringing about on the New York side of the Harbor much needed improvement. I am frank to say that combining financial and administrative procedures, it has been my view, and I have stated this pretty frankly on all occasions, that the piecemeal style of procedure, taking up certain sections of the Harbor that are grossly polluted now, they should be eliminated first; that there should be brought about a program for so much money each year for a term of years; that that would probably be the best that could be done, provided that all those works were for the most part arranged so that for several generations hence a program would allow their use to be made in connection with an ocean outlet for at least a portion of the sewage of this district. I don't want the record to show my view as one of subscribing to an exhaustion of dissolved oxygen in the harbor waters beyond and below reasonable limits. I

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am firmly of the opinion that these waters must be left in a situation that is inoffensive to the various items recited in this stipulation. I speak of that for the Metropolitan District as a whole.

Q. What would you regard, Mr. Fuller, as a margin of safety for the oxygen content in these harbor waters?

A. If you can keep it at twenty to thirty per cent, I am
169 absolutely certain that it would be safe, provided you could eliminate the great complication which arises from the sewage sludge which is now building up so markedly and has for years at various places on the New York side of the Bay, but it will be absolutely eliminated so far as the Passaic Valley sewage is concerned, when those treatment procedures go into service.

Q. And with an oxygen content of thirty per cent of oxygen saturation, you would expect no nuisance, is that correct?

A. I am absolutely sure of it, provided you keep this sluge complication eliminated.

Q. But if the oxygen content of the supernatant water was thirty per cent of oxygen saturation, you would not expect a nuisance?

A. I would not, but let me make plain in each of my answers now, that I am clearly carrying in mind the elimination of the sludge deposits which do build up every day in the year, and with the accumulation at the end of a summer will build up accumulatively during the autumn, winter and spring, and you throw the load as to using up oxygen onto those over-lying waters during the warm months of the summer, and when you don't get nature's kindly refrigerator methods, which through the cold weather stop the
170 sludge digestion for the most part through the winter. I am speaking of the thirty per cent dissolved oxygen content, without any sludge complications, and I have no hesitancy in saying that if you got down to fifteen per cent I don't believe you would ever see any difficulty at all, with the overlaying waters. Let me illustrate that; my own observations in London, and the Lower Thames—I am speaking of the Thames its lower reaches, below the City of London, and in respect to conditions which result in consequence of having sewage of that Metropolitan District brought to the two sewage treatment plants at Barking and Crossness. The point in particular is, that the sewage reaching these two sewage treatment plants is freed of the suspended matters, and leaves as relatively clear sewage going into the River Thames. Under those circumstances you can get a dissolved oxygen content which gets to be ten or less, without getting a nuisance. And I carry conspicuously in mind as an element, in explanation of that situation, the freedom from the sludge deposits.

That matter I have personally inspected on quite a number of occasions, and I have been impressed with the facilities that they have
171 for watching that condition of the Lower Thames very carefully. They have boats for the purpose affixed with laboratory equipment. They have glass bottoms to these boats. They have little pump attachments by which they can get samples of water and make the test of dissolved oxygen within a few minutes, so you can not only observe things as you see the surface and

conditions of the water, but you get the dissolved oxygen content. I have had the opportunity of making such a trip on a number of occasions. I want to consult my data to indicate the dissolved oxygen content at London.

Q. What book are you now consulting and quoting data from, Mr. Fuller?

A. I am looking at the Philadelphia report on the Collection and Treatment of Sewage, published in the year 1914, and showing a diagram of data which was furnished to Mr. Datesman and corresponding to the information which was similarly furnished to me by Sir Maurice Fitzsimmons, the chief engineer of London County Council. It occasionally gets down below ten during the summer, it is generally, though, twenty to thirty per cent.

Q. And through these glass-bottomed boats that you have described, can they see whether or not there are sludge deposits on the bottom of the river?

A. They can make observations, and the sludge deposits
172 are generally absent, incident to the clarification process.

Q. The treatment is chemical precipitation?

A. It was for a term of years beginning with the early history of these works; it was about 1896 or thereabouts on to about 1910 or 1911, since which date they have resorted to plain sedimentation without chemical precipitation.

Q. What is the detention period in the sedimentation plant at Barking?

A. I cannot tell you offhand.

Q. Is it more than an hour?

A. I think it is a little.

Q. How many hours would it be?

A. I cannot tell you from memory; the basins are long; they have that phase of the old time practice quite conspicuously, I think the velocity, however, would not be in excess of what I call the critical velocity. They would have the benefit of the lower velocity, such as I testified to yesterday here for these Passaic Valley basins.

Q. But as the result of the treatment of the sewage of London at Barking and Crossness, they remove all matters that would occasion sludge deposits?

A. That is the intent, just as it will be here in the Passaic Valley project.

173 Q. And they accomplish that result, do they not, by their treatment, that there are no deposits?

A. They do to a substantial and practical degree. I cannot say that there would be absolutely no deposits, but I think that is substantially the result.

Q. What do you know about the deposits of sewage sludge in the Upper Bay of New York?

Mr. Riker: Same objection to the question, immaterial and irrelevant and not cross examination.

Commissioner Maher: The objection will be noted.

A. I have investigated that from time to time and know that in certain arms of the Upper Bay, the Gowanus Canal, which I visited a couple of weeks ago, that there are deposits there. There are deposits generally around the slips of the ferries and different boat landing piers, sludge to a considerable extent. There is also some sludge on the floor of the Bay, but that is not universally found. There is a large volume of sludge fairly close to the shore around a large portion of the waterways of the Upper Bay.

Q. Have you read the reports of the New York Bay Pollution Commission and of the Metropolitan Sewerage Commission?

A. Yes, sir.

Q. Do you recall the devices recommended or designed by
174 Professor Landreth for the purpose of determining the condition of the deposits in the Upper Bay of New York.

Mr. Riker: Same objection as I made to the last suggestion.

Commissioner Maher: The objection will be noted.

A. Yes, I studied those reports at the time. I cannot recall precisely what his detail was, but I know that they took deposits from the bottom of the Bay with a view of trying to get at the depth, and to draw those samples so that they could subject them to microscopic examination and get a line on their source.

Q. Do you recall in the testimony of Professor Landreth, that matter regarding the Bar before you get to the Narrows which holds the sewage ooze of sludge from escaping into the Lower Bay?

Mr. Riker: The question is objected to on the same ground.

Commissioner Maher: The objection will be noted.

A. No, I cannot say that I remember that feature, but I do remember the fact that when the Ambrose Channel was dredged they found substantial deposits of sewage sludge mixed with the silt and
175 sand, and that the amounts of those sewage deposits varied in different places.

Q. Do you recall any estimate as to the depths of the sewage deposits throughout the floor of the Upper Bay of New York?

Mr. Riker: Same objection.

Commissioner Maher: The objection will be noted.

A. I have no record of the findings with me, but it is my recollection that the depths ran to quite a number of feet, in places.

Q. Thirty feet in places?

A. I should have said ten feet or more in places. I cannot say that I would be surprised if they were more. I simply don't know the depths now.

Q. Have you had an opportunity to study the contour map prepared by Mr. Knichling in this suit, the contour map of the Upper Bay of New York, showing the various pockets and depressions and the peculiar influence of the sand bar on the southern boundary of the Upper Bay of New York leading to the Narrows, which retains

the sewage deposits and carpets the floor of New York's Upper Bay with that sewage sludge?

Mr. Riker: Same objection.

Commissioner Maher: The objection will be noted.

A. I have not in mind a clear account of that; I knew
176 that there was such a map prepared.

Q. Assuming that the deposits are, as you say, ten feet or more of sewage sludge in the Upper Bay of New York, what would you regard as a safe margin for the oxygen content, in percentage, saturation, under such conditions?

Mr. Riker: The question is objected to on the ground that the witness has not laid any basis, nor is there any evidence to sustain the assumption that there is a deposit of over ten feet of sludge on the floor of the Bay of New York, the witness's testimony being that at certain places there are deposits of that amount.

Commissioner Maher: The objection will be noted.

A. I believe that a dissolved oxygen content of twenty-five to thirty per cent is ample, but I should make plain that I am assuming now that sludge from this time on, or from a certain fixed date on, or from some fixed date, will be eliminated, and that with respect to present accumulations, they will be remedied by dredging from around the slips or wherever they accumulate, to very great depths. I make that comment to indicate that I am not car-
177 rying in mind any fanciful program of trying to dredge shallow deposits over the entire area. I believe that the money spent for dredging should be done where it will do the most good.

Q. Have you seen any of the dredged material during the deepening or perfection of the Ambrose Channel?

A. I have been by it in boats, going to Atlantic Highlands; I made no special trips for that purpose.

Q. Do you know the character of the material they took up at all?

A. I know it was a black objectionable material in some instances.

Q. That it made many of the crew sick and they had to desist from the dredging operation during the warm months?

Mr. Riker: Same objection as the last.

Commissioner Maher: The objection will be noted.

A. I am not informed about that.

Q. Under the conditions that there are deposits there now, what would you consider the safe margin, under existing conditions, for the oxygen content in the Upper Bay of New York?

Mr. Riker: The objection is made that the question involves a hopothesis which has not been shown to be in accordance with the fact based on any evidence given by this witness.

178 Commissioner Maher: The objection will be noted.

A. I have not made a study of that; I am of the opinion that these coarse deposits around the slips should be removed and their entrance in the future should be prevented.

Q. The putrefaction going on in the sewage deposits in places like the Upper Bay of New York is invariably anaerobic?

Mr. Riker: The question is objected to as immaterial and irrelevant.

Commissioner Maher: The objection will be noted.

A. Yes, other than the first few hours on days when the deposits occur, the great bulk of the decomposition is accomplished anaerobically.

Q. You make distinctions between the terms decomposition, putrefaction and fermentative action?

Mr. Riker: The same objection.

Commissioner Maher: The objection will be noted.

A. I have not fixed nomenclature.

Q. You do know that some do make distinctions?

A. Yes, anaerobic decomposition and aerobic decomposition are terms that are generally understood. Some speak of those as petrefaction and fermentation.

179 Q. The anaerobic decomposition changes give rise to putrefaction gases that are objectionable to the sense of smell and destructive to metals and other property; is that not so?

A. Yes, it is true, provided the gases are not absorbed by the overlying water. The gas which one sees bubbling from the surface of the liquid overlying putrefied sludge deposits is for the most part inoffensive. It is the same gas which you see in the pools of the forest and the old-fashioned mill ponds, where sawdust has brought about the decomposition, but accompanying that decomposition there are sulphur compounds, like sulphuretted-hydrogen, that have the rotten-egg flavor, and they are produced in quantities sometimes that are not absorbed by the overlying water. In that event they do produce objectionable odors.

Q. Will fresh water or salt water absorb the largest quantities of these putrefaction gases?

Mr. Riker: I make the same objection.

Commissioner Maher: The objection will be noted.

Q. (Continuing:) And hold them in solution?

A. I cannot tell you from memory. I know salt water contains less oxygen than fresh water, but I am not informed about the other gases.

180 Q. How much less?

A. Roughly, ten per cent, I should say, with about equal mixture of fresh water and salt water.

Q. Isn't it fifteen per cent?

A. Perhaps it is, I will be guided by the facts. I am not very good in remembering those details.

Q. What do you describe the waters of the Upper Bay in New York as, fresh water, salt water or brackish water?

A. Brackish.

Q. About what percentage is approximately fresh and salt water?

A. It varies a good deal at different seasons of the year. I haven't clearly in mind the range. I have looked at that data as given in Mr. Parson's report, the salinometer test.

Q. Isn't that an important factor in considering sewage digestion by dilution as to what percentage of fresh and salt water are in the recipient waters?

A. It shows what is the amount of oxygen that would be available, that is dissolved oxygen for aiding digestion process in an inoffensive way.

Q. Does the oxygen enter into direct chemical union with the organic matter, or is it utilized by certain forms of microscopic life in the disintergration processes?

A. It is the indirect, latter method.

181 Q. And in brackish water you get the lowest possible plankton content?

A. Yes, among other things.

Q. So that the digestive capacity of brackish water is far lower than that of either fresh water or salt water, is that not a fact?

A. It is somewhat less, I think. I wouldn't say very strongly that brackish water is a less desirable diluting element than fresh water; it is somewhat less desirable.

Q. Will fresh water bacteria live in the presence of the saline matters in brackish water?

A. You get a disturbance of bacteria life, that is a fact.

Q. Isn't a large part of the harbor deposits due to death of the bacteria that come in from the ocean and are marine bacteria, and to those that come in the land water and are fresh water bacteria?

Mr. Riker: If you know.

A. I don't know. I should assume that those bodies of bacteria are eaten up by the larger forms of plankton life.

Q. Don't you know that a frog placed in salt water would lose twenty-five per cent of his weight inside of an hour, due to the absorption of the watery elements in his system by the saline matters in the salt water?

Mr. Riker: The question is objected to as immaterial and
182 irrelevant, and as involving the assumption that a frog is a bacteria.

Commissioner Maher: The objection will be noted.

Mr. O'Sullivan: The question is pressed to show that these fresh water animals and fresh water bacteria cannot subsist in salt water, or where saline impregnation is rather considerable, and if that be true of a frog, it shows how little chance the microscopic fresh water bacteria or micro-organisms have.

Commissioner Maher: The statement of counsel will be noted.

A. I am unable to answer the question.

(Recess.)

Q. Mr. Fuller, from your personal knowledge of the conditions in the Upper Bay of New York, what percentage of oxygen saturation would you regard as a safe margin for that body of water?

A. I would put twenty-five to thirty per cent as a general margin, but as I have said repeatedly, I would not feel that any disadvantages would result with much lower percentages, provided this sludge question were attended to.

183 Q. Recognizing that the sludge deposits are there now, and that this is a body of brackish water, about equal parts of fresh and salt sea water, and is receiving large contributions of sewage and trade waste, what would you regard under the present conditions as a safe margin for the oxygen percentage saturation for that body of water?

Mr. Riker: I object on the ground that it does not appear at what point the oxygen saturation should be determined.

Commissioner Maher: The objection will be noted.

A. I still adhere to the twenty-five to thirty per cent oxygen content, if that were found in all portions at all times of the New York Bay. I am taking fully into account the brackishness of the water.

Q. Do you know of any bodies of water where sewage sludge is deposited in the bottom of the water area and where the oxygen content would be thirty-five per cent of normal saturation, where a nuisance exists?

A. No, I don't recall any.

Q. Have you personally made any oxygen determinations either in the Upper Bay of New York, the Hudson River, and East River, Newark Bay or the Passaic River?

A. No.

184 Q. Are you familiar with any oxygen determinations that have been taken at any time in Newark Bay or the lower reaches of the Passaic River?

A. I have studied results as they have been reported in documents that I have had access to, but not for some time.

Q. What would you expect the oxygen determinations to show in the Passaic River in the region of Newark, as to its percentage of oxygen saturation?

Mr. Riker: The question is objected to as not cross-examination and dealing with an expectation and not with a fact.

Commissioner Maher: The objection will be noted.

A. I have not looked at reported data on that question for some time.

Q. Does a nuisance exist in the Passaic River in the region of the vicinity of Newark?

A. Well, it is a black foul stream giving off some odors in the sum
mer time.

Q. Would you say that it created a nuisance there?

A. I should say it was an objectionable condition, yes, sir. I a
not informed particularly as to the extent to which odors arise there

Q. And do I understand your testimony, Mr. Fuller, to
185 that if there was twenty or thirty per cent of oxygen show
by determination, that no nuisance would exist?

Mr. Riker: The question in the form in which it is, is objected
on the ground that it omits to state one of the conditions, which i
the absence of sludge deposits.

Commissioner Maher: The objection will be noted.

A. I think there would be no nuisance if you were to eliminate th
sludge deposits.

Q. There are sludge deposits in the Passaic River in the region
Newark, are there not?

A. I think there are.

Q. Can you give me any idea of what the oxygen determinatio
have been for the Passaic River in the vicinity of Newark?

A. No, I cannot tell you from memory.

Q. Earlier in your examination, Mr. Fuller, you stated that yo
were aware of the fact that Professor Earl B. Phelps, and Colon
William M. Black conducted oxygen determinations during man
months throughout the waters of New York Harbor?

A. Yes.

Q. Do you know whether or not they made determin
186 tions in Newark Bay and the Passaic River at that time?

A. That is my impression, they made a few observations.

Q. I direct your attention to an excerpt which I show you fro
volume 2, page 1602, folio 2375, in part of an answer given by Pr
fessor Earl B. Phelps on his direct examination, after testifying abou
conditions found in other rivers and other regions of the country,
to their oxygen content; I read the latter part of an answer given:

"The condition of the Passaic River, even in the winter time,
too serious to call for any comment. I made an examination of th
waters of this river at Newark in the fall of 1910 and found ther
thirty-eight per cent saturation of oxygen."

Do you find that as I read it?

A. Yes, sir.

Q. He states that the conditions there were too serious to call fo
any comment, in the presence of the oxygen content found to b
thirty-eight per cent of normal saturation. Do you still adhere t
the view that in the presence of thirty per cent of oxygen, no nuisanc
will exist if there are sludge deposits?

Mr. Riker: The question is objected to on the ground that it state
a condition which is directly the negative of the one that the witne
has already assumed.

Commissioner Maher: The objection will be noted.

187 A. I think this situation at Newark in the Passaic River is wholly a function of the decomposing sludge, so far as offensive conditions are concerned. It does not modify my view in any way.

Q. Not even to the extent of stating that there will be no nuisance if the oxygen content would run between twenty and thirty per cent of normal saturation?

A. If you leave out of view the decomposing sludge, then a residue or residual oxygen of twenty or thirty per cent will be sufficient to guard against any offensiveness arising from decomposition.

Q. Distilled water from which all oxygen has been driven will not give offensive odors with the absence, or rather the entire absence of oxygen, will it?

A. That is true.

Q. And it is the organic matter that is discharged into bodies of water, and that through the ministrations of bacteria consume oxygen, and when the oxygen is depleted below a certain point that will occasion nuisance; is that not so?

A. That is a correct general statement. I want to make it plain that in speaking of thirty per cent or twenty per cent of residual oxygen, I carry in mind very positively now, that that should obtain everywhere; if that obtains at all points with which the water
188 has contact, then you will not get offensive decomposition. Perhaps I haven't made it plain, that if you get enough into this sludge and stop your anaerobic decomposition, then I am convinced that you would have no objectionable putrefaction.

Q. Mr. Fuller, can you state what the ratio is between the depletion of the supernatant waters of their oxygen through the anaerobic decomposition of sewage sludge and the aeration of those waters at the surface from the air, and what the percentages relatively are?

A. I cannot state that in any very precise way. I know that reaeration is a very important factor in considering oxygen content of large bodies of water exposed to the wind.

Q. Is it not a fact that while sewage sludge is undergoing anaerobic decomposition it will deprive the supernatant waters of thirty per cent of their oxygen content, while the aeration process taking place on the surface of the water only equals one-tenth of one per cent of an addition of oxygen within the same period of time?

Mr. Riker: The question is objected to on the ground that it is not cross-examination, is immaterial and irrelevant and is
189 new evidence and introduces matters which are not allowed by the order of March 10, 1919.

Commissioner Maher: The objection will be noted.

A. I am unable to give any very specific answer to a question like that. I know that aeration as stated in this question bears close resemblance to statements made in Professor Phelps' report. My study of that subject leads me to believe that the Professor has rather underestimated the effect of aeration. It is feasible to get decomposition in the sludge, in the absence of oxygen in a body of water, where a body of water overlying such sludge contains more or less

oxygen; I recognize that that is all true. In all my answers I have endeavored to make it plain that this figure for residual oxygen which I am stating, either eliminates the sludge or else provides that this extent of residual oxygen shall prevail in the sludge itself. If you get sufficient oxygen present for decomposition of sludge or sewage or organic matter generally, on the anaerobic basis, then this putrefactive condition that you speak about cannot arise. That is one of the fundamental laws of bacterial processes.

190 Q. May you not have both forms of disintergration taking place in the same body of water—aerobic decomposition changes in the upper strata of the water and anaerobic decomposition changes in the lower strata and in the deposits beneath the supernatant water?

A. That is possible, but with the residual of oxygen, as I have repeatedly explained, that situation may not obtain.

Q. Is it not a fact that that is exactly the condition that is now taking place in the Upper Bay of New York,—aerobic decomposition changes in the upper strata of the water and anaerobic decomposition changes in the very lowest strata and in the sludge deposit beneath the water?

A. I don't think that is generally true. There are probably places where that situation could be found.

Q. Can you give any approximate estimate as to what the oxygen content at any points in the Upper Bay of New York are now?

A. I made no tests but I have studied published data; that is the only source of my information. That is not the branch of this inquiry to which I have given specific attention.

Q. Did you at any time, Mr. Fuller, believe that the Passaic Valley sewage as transported in the trunk sewer would reach the disposal works in a septic condition?

191 A. I have thought that the dissolved oxygen would be largely reduced from the flow of sewage from Paterson and Passaic, for instance, by the time it reached the lower end of the trunk sewer, but with the big volume of sewage reaching the pumping station from Newark, which is closely adjacent to that station, I have not considered at any time it would be a septic sewage.

Q. When it reached the disposal works?

A. When it reaches the disposal works.

Q. Is it not a fact that septic sewage very readily infects fresh sewage and renders it equally septic?

A. There is a tendency in that direction; I wouldn't say that it would ordinarily bring about septic action; in fact, that is a process which we find in septic tanks requires some six weeks to become effectively established.

Q. Did you aid in the dictation of the report made by Hering and Fuller to the Passaic Valley Sewerage Commissioners on the thirty-first of December, 1907?

A. I participated in the preparation of the report.

Q. Do you recall whether or not that report embodied the statement that the sewage would be black and septic when it reached the disposal works after transit in the trunk sewer?

Mr. Riker: The question is objected to on the ground
192 that the report is the best evidence, or the contents of it.
Commissioner Maher: The objection will be noted.

A. I do not remember.

Q. I call your attention to Volume 3, of the record in this case, page 2852, folios 4197-4198, in the testimony given by Mr. Rudolph Hering, the senior member of the firm of Hering and Fuller; I read:

"Q. I call your attention to page 3990 of the record of minutes made by the stenographer at the hearings in this suit, (being page 2493, volume 3, of this printed record) and ask you to consult your copy of the report made by Hering and Fuller for the Passaic Valley Sewerage Commissioners, dated December 31, 1907, and see if you find the following quotation from your report therein, as reported on said page 3990 of the stenographic minutes in this case:
"The indications are"——

I am reading now from a part of that report.

Mr. Riker: Aren't you reading from the testimony?
Mr. O'Sullivan: Yes, but it is part of the report that is embodied in the question.
Mr. Riker: It is part of the testimony that you are reading isn't it?
Mr. O'Sullivan: This is a part of the report embodied in the question.

Q. (Continuing:) "The indications are under present
193 conditions that the sewage as it reaches the pumping station on the Newark Meadows will normally be devoid of dissolved oxygen. From the foregoing result it seems quite plain that even though the discharges of the several outlets contribute considerable dissolved oxygen, this will be quite speedily absorbed; In its travel of twenty miles in some ten hours, it will become septic, but the more or less constant addition along the route of sewage containing dissolved oxygen, will retard rapid putrefaction. As received at the pumping station the sewage will doubtless be septic and blackened."
Do you find that quotation as I have read it in your report of December 31, 1907, to the Passaic Valley Sewerage Commissioners?
A. I do so find it.
Q. Was that report along with your plans adopted by the Passaic Valley Sewerage Commissioners?
A. I presume it was."

Do I read the questions put to Mr. Hering, and the answers given by him as you can find them in Volume 3, page, 2852, correctly?
A. Yes.
Q. Does that refresh your recollection as to the report in which you participated, that Mr. Hering and you made to the Passaic Valley Sewerage Commissioners, dated the thirty-first of December, 1907?

A. Yes, it brings to mind the rather loose way in which the word "septic" was used. I have no doubt that there would be a blackened appearance. This would not be fresh sewage, that is true.

194 The question of exhaustion of oxygen in summer months is quite likely to be found. The question of the extent of septic action is largely the function of those stranded solids which I spoke about yesterday at considerable length. At that particular date the minds of all the Hering and Fuller men were pretty well saturated, so to speak, with experience at Columbus, Ohio, where there was an intercepting sewer that had large accumulations of sludge in it, and I don't believe that septic sewage would be found in a trunk sewer if these solids can be kept from stranding and depositing there. That same line of thought which underlies the quotations which you read from the Hering and Fuller 1907 report prompted me yesterday, in my direct examination, to bring to the front as a means of betterment, the absolute minimizing of solids and the replenishing of air by aeration.

Q. And your remedy for these stranded solids in these flat-graded sewers would be to introduce dams in the sewers and hold the sewage back and then let it flush out the deposited solids?

A. I found that to be very successful in some cases. I am not trying to make a pronouncement as to the precise detail of the operating men in charge of the various collecting systems. I made that and other suggestions as a perfectly practicable, reliable means of preventing these stranded solids.

195 Q. And you offered it as a suggestion for modification in the present plans of the Passaic Valley Sewerage Commissioners, towards improving the efficiency of that plant and diminishing the polluting influences of the effluent to be discharged from it into the Upper Bay of New York?

A. I offered that as a procedure which might prove helpful as regards the collecting sewers which are tributary to the trunk sewer. I think the trunk sewer itself would not show these deposits with the variation in the rate of pumping which I have discussed. I perhaps did not make myself plain in regard to the elimination of the stranded solids. That was intended to apply to the branch line structure rather than the trunk line itself.

Q. During that damming up process would you expect sedimentation to take place in the sewage that would be dammed up and which would later be employed to flush out the deposited matter?

A. Oh, yes, the checking of the velocity would cause deposits, but that would be released upon the removal of the dam—upon opening of the gate.

Q. What particular sewers did you have in mind when you discussed these deposited solids?

A. You mean in this Passaic Valley?

196 Q. Yes.

A. I would apply that generally to those sewers where it is found necessary. I spoke in my direct examination of certain flat areas, for instance, here in Newark east of the Pennsylvania tracks.

Q. How many communities have already entered into contract with the Passaic Valley Sewerage Commissioners and contemplate contributing sewage and trade waste to the trunk sewer?

Mr. Riker: The question is objected to as not cross-examination, immaterial and irrelevant, and not allowed by the order of March 10, 1919.

Commissioner Maher: The objection will be noted.

A. I am not informed on the subject.

Q. Wasn't part of your duty the preparation of the contracts to be entered into by these communities and the Passaic Valley Sewerage Commissioners?

Mr. Riker: Same objection.

Commissioner Maher: The objection will be noted.

A. No.

Q. Did you not so testify in this proceeding yesterday?

A. Getting out material for that contract, but the actual contact and reference with the people representing the different
197 municipalities; that is not a part of the work that we did; that was in the hands of the administrative and legal officers of the Passaic Valley Sewerage Commission.

Q. Do you know of any of the communities that are about to contribute sewage to the Passaic Valley trunk sewer?

A. Yes, I know some of them.

Q. Taking the upper ones, taking Paterson, what kind of a sewerage system have they got for their local sewage?

Mr. Riker: Same objection.

Commissioner Maher: The objection will be noted.

Mr. Riker: The further objection that counsel is taking time for this cross-examination that is unnecessary.

Commissioner Maher: The further objection will be noted.

A. It is my recollection that the Paterson sewerage system is for a large part on the combined system, that is, the sewers are double sewers, carrying both sanitary waste and storm water. The program contemplates the use of separate systems of sewers for extension work and ultimately the separation of the storm water and sanitary sewage in areas which have already been sewered.

Q. How many of these communities are sewered with the
198 separate or sanitary system?

Mr. Riker: The question is objected to on the ground that he has stated that he did not know which ones entered into the contract and therefore he cannot tell how many have the separate system.

Commissioner Maher: The objection will be noted.

A. I am not informed on the matter.

Q. What is the grade of the Passaic Valley Trunk sewer between Paterson and Newark?

A. I am unable to tell from memory. I have looked into the

matter in the last eight or ten weeks, but I have not the information with me and cannot tell from memory.

Q. Not knowing the grade, how can you determine the velocity with which that sewage will travel between Paterson and the sewage disposal works on the Newark Meadows?

A. I looked into that matter from the standpoint of seeing whether a velocity of two and one half feet per second could be secured for a long portion of a twenty-four hour period, and my inquiry led me to conclude that that could be done, and if it were not done with the natural flow, it could be done by varying the rate of pumping. There will be no stranding of solids in the trunk sewer of the
199 Passaic Valley Sewerage Commission with any reasonable operating program.

Q. How many times will the sewage and trade waste be pumped before it reaches the sewage disposal works on the Newark Meadows and after it leaves Paterson?

Mr. Riker: If you know.

A. I haven't looked into that detail for some time.

Q. Are there many pumps?

A. There are pumps on branch connections, but not on the main trunk.

Q. On how many of these branch connections are there syphons and pumps?

A. I am really not informed on that detail and haven't looked into it in detail for ten years.

Q. Isn't it necessary to know in what condition the sewage would reach the disposal works before you could give an opinion on the efficiency of the screening and sedimentation devices adopted by the Passaic Valley Sewerage Commissioners for the disposal works and for the treatment of this sewage?

A. I have looked into all these questions in earlier years and I will accept as part of the premises all of the facts in the case. I know that there is some of the sewage pumped and I know there are some syphons, and I know that some of these have been built
200 and will be operated with reasonable adjustment to the best sanitary practice.

Q. Are not practically all of the sewerage systems of the communities with one exception—on the combined system, of all these communities that entered into contract with the Passaic Valley Sewerage Commissioners?

A. I do not know.

Q. Do you know how many by-passes have been arranged to give exit to the sewage to be transported during storm periods in the Passaic Valley Trunk sewer?

A. No.

Q. Do you know that there is a regular by-pass chamber in connection with the sewage disposal works themselves for allowing all the sewage to escape into Newark Bay?

Mr. Riker: The question is objected to on the same ground as before stated, and as embodying a statement of fact which is not a fact.

Commissioner Maher: The objection will be noted.

A. I know that there are some overflow regulators at the foot of these existing sewers where they are connected into the trunk sewer. I do not recall the overflow at the pumping station.

Q. Do you make a distinction between an overflow station and a by-pass station?

201 A. I presume you are referring to the same thing. What I mean is, that if you have a large sewer here in Newark that now discharges into the river, and in it will go storm flow, there will be a regulating device so that the dry water flow and a limited portion of the storm water flow will be diverted from the trunk sewer. When the storms come and the flow exceeds the capacity of that connection at that regulating chamber, then that surplus has gone out into the river. That is my understanding of what you are speaking about.

Q. The first contribution of storm water during a storm is very foul sewage, is it not?

A. It may be if there has been no preceding storm for a long period and streets are not kept clean; it is possible.

Q. In what condition would you expect the sewage to reach the disposal works as to its being finely comminuted or not?

A. The sewage from the upper end of the district where the period of travel has been for a considerable distance, that is, in both point of time and distance, that sewage would be relatively comminuted; its larger particles would be broken up into smaller ones. That is not true at Newark, as regards the length of travel. Of course, the sewage of any large city is comminuted as compared with the

202 sewage you get in a small residential village or plant.

Q. Is that true of Manhattan sewage?

Mr. Riker: Objected to on the ground that it is immaterial and incompetent.

Commissioner Maher: The objection will be noted.

Mr. O'Sullivan: The question is pressed for the reason that this witness has testified as to the disposal systems that are available for the City of New York for the treatment of its sewage.

Mr. Riker: The statement of counsel is objected to as part of the record, because this witness has not testified as to the systems that are available for New York.

Commissioner Maher: The further objection of counsel will be noted.

A. It is not true to the extent ordinarily found in large cities. It is a long island and the length of travel in the most cases is shorter than you ordinarily find it.

Q. And the trunk sewers go on each side of the island and at practically every cross street, is not that so?

A. In a rough way that is so.

203 Q. And the age of the sewage from the time it is deposited in the closet until it reaches the water would average about fifteen minutes, is that not true?

Mr. Riker: If you know.

Mr. O'Sullivan: Men who measured it have already testified to it.

Mr. Riker: Then why ask him?

A. I made no study of that. I know that that wouldn't be true in a good many cases, and it may be in others.

Q. One of your instructors in the Massachusetts Institute of Technology you mentioned as Professor William T. Sedgwick, did you not?

A. Yes.

Q. Is he an eminent sanitarian and authority on public health?

A. Yes, in special reference to transmission of diseases and biological aspects of sanitation.

Q. Has he knowledge on sewage disposal and sewage disposal systems?

A. He has with regard to the theory but not with regard to the practice. I should say he is a laboratory man and knows theories and prophesies pretty well. I don't know of his having had experience in the construction or operation of disposal plants in any place at all.

Q. I direct your attention to Professor Sedgwick's testimony as to the condition in which the sewage transported in the Passaic
204 Valley trunk sewer would reach the disposal works on the Newark Meadows, volume 3, pages 2820, 2821, folio 4152:

"Q. Professor Sedgwick, in what condition would you expect the Passaic Valley sewage to reach the Newark Meadows after several pumpings and after many hours in transit?

A. I should expect it to arrive finely divided and already freed from heavier suspended particles such as sand and things having high specific gravity, but passing very rapidly through screens. That is in fact the way in which the sewage arrives at Nut Island, very little being held back by the screens.

Q. Will the great mass of that sewage pass through a screen 4/10ths of an inch in mesh?

A. It certainly will.

Q. What condition would you expect the sewage to be in as to septicity when it reached the sedimentation tanks?

A. In summer I should expect it to be destitute of oxygen and often in a stinking rotten condition, a condition commonly described as distinctly septic."

Do I read this testimony correctly, Mr. Fuller?

A. Yes.

Q. Do you agree with the evidence there given by Professor Sedgwick after careful study of the subject matter to which he testified?

Mr. Riker: The question is objected to as immaterial and irrelevant; the witness has already testified to his view which either does

or does not agree with Professor Sedgwick's somewhat lurid opinion, as will appear by the record.

Commissioner Maher: The objection will be noted.

205 A. I think the Professor overstated the case, in my judgment. My views I have stated in answer to a recent question here.

Q. In reading through the testimony did you find similar opinions expressed by Mr. Desmond Fitzgerald and Professor Winslow, Mr. John W. Alvord of Chicago, Mr. Harrison P. Eddy of Boston, and several others of the sanitary engineers who testified for the complainants?

Mr. Riker: The question is objected to as being immaterial what these others may have testified to.

Commissioner Maher: The objection will be noted.

A. I think they have opinions similar to Professor Sedgwick and from which I differ.

Q. The Chief of Staff in the firm of Hering and Fuller was Mr. Rudolph Hering himself, was he not?

A. Yes.

Q. Did you read the testimony he gave adversely to this project of the Passaic Valley Sewerage Commissioners for discharging this effluent in New York Bay?

Mr. Riker: The question is objected to as stating what is not borne out by the record, that he testified adversely; on the contrary, he testified that in his opinion the certificate which he furnished,
206 which is Exhibit D. 5, is in accordance with the view which he held at the time that he gave the testimony, and that he believed that the result would be as stipulated.

Commissioner Maher: The objection will be noted.

A. I read Mr. Hering's testimony.

Q. Did you consider it adverse or favorable to this Passaic Valley Sewerage Project?

Mr. Riker: The question is objected to on the ground that the testimony speaks for itself, and that the opinion of this witness need not be called for as to the effect of it.

Commissioner Maher: The objection will be noted.

Mr. O'Sullivan: The question is pressed for the reason that this witness has testified that the great source of his knowledge here since March of this year up to the time he is testifying has been his studies of the record in this case.

Mr. Riker: I object to that statement. I regret to say that it does not conform to the testimony of this witness.

207 Commissioner Maher: The objection will be noted.

Mr. Riker: He never used the words "The great source of his information was the record."

A. I gathered from Mr. Hering's testimony that this Passaic Valley Sewerage project for some time would give results set forth in this exhibit of the Defendants, marked No. 5.

Q. Do you recall whether or not he stated that these screens would fail in keeping out the great mass of the sewage that would not be affected?

A. I do not recall, but I should assume at once, or what is the obvious fact, and that is, they will take out matters which are larger than that screen separation would deal with, and I am very firmly of the opinion that the screening proposition is the separation according to the size of the materials actually in the sewage to be treated.

Q. But if the sewage is finely comminuted, these screens would not be effective, would they?

A. No, they would not, but that comminution would not apply to the great bulk of the sewage which is from the Newark end of the district.

Q. Mr. Rudolph Hering has been a student of this project from 1897, has he not, long before your connection——

A. With the Passaic Valley Project?

208 Q. Yes.

A. No, I was a partner of his in 1901, when he first considered it.

Q. Wasn't he connected with the problem in 1897?

A. No, sir, that work was done by Mr. Fetley and Mr. Jacobson; that is the first Passaic Valley Sewerage disposal report by engineers.

Q. In reading this testimony in the record in this case, do you know whether or not he recommended separate disposal systems for the various communities or advocated their entering into contract with the Passaic Valley sewerage Commissioners?

Mr. Riker: Objected to on the ground that the record itself is the best evidence of the testimony which he gave.

Commissioner Maher: The objection will be noted.

A. Generally speaking he recommended that the communities join in this trunk sewer project. He rather got into active consideration as to the assessment charges, and I think did take a stand indicating that local sewage disposal plants or projects should be considered for one or more of the communities. I speak now with particular reference to Montclair, which is his home town.

Q. And both the Oranges?

209 A. I don't think he advised the Oranges; he may have done so. That was purely a matter of assessment charges, not in any way involving the sanitary aspects of the case.

Q. He mentions both Montclair, Orange and East Orange, in his testimony as being retained by them?

A. No answer.

Q. When did the Passaic Valley Sewerage project first receive inception do you know?

Mr. Riker: The question is objected to on the ground that it is not cross examination; immaterial and irrelevant.

Commissioner Maher: The objection will be noted.

A. It was some months prior to the Fetley and Jacobson report of 1897, to the best of my knowledge.

Q. Mr. Hering was retained to furnish plans then for the relief of the problem submitted to the Passaic Valley Sewerage Commissioners, was he not?

Mr. Riker: The witness has said no; the question is objected to because the witness has said recently that it wasn't until 1901 that Mr. Hering came into it.

Commissioner Maher: The objection will be noted.

A. No, I do not think Mr. Hering had anything whatever
210 to do with the first 1897 report.

Q. Nor at any period between that and 1901?

A. Not to my knowledge.

Q. The earlier plans contemplated a discharge of this sewage into Newark Bay, did they not?

A. I believe so.

Q. And you were refused a permit for that discharge of the trunk sewer outfall into Newark Bay by the War Department were you not?

A. I do not know.

Q. Was that before your connection with the case?

A. I had nothing to do with this sewering of the lower Passaic Valley prior to 1901. I believe the Standard Oil interests at Bayonne took rather a strong view in that matter, but that is merely hearsay, so far as I know.

Q. Do you know whether screening and sedimentation is an entire treatment for sewage?

A. If the work which they accomplish is sufficient for the local conditions, yes, but not for all cases.

Q. Do you know whether or not, in reading Mr. Hering's testimony that he regarded that as not an entire treatment and not an adequate treatment for the Passaic Valley Sewage?

211 Mr. Riker: The question is objected to on the ground that his testimony is in the record, and it is the best evidence of what he testified to.

Commissioner Maher: The objection will be noted.

A. I don't recall what he said in that particular, I am not prepared to discuss that.

Q. Do you know whether or not in his testimony he recommended filtration as a proper addition to the present project?

Mr. Riker: The same objection.

Commissioner Maher: The objection will be noted.

A. I think he took the view that that was not necessary for a long term of years. What he may have said with respect to the far distant future I do not recall.

Q. The discharge contemplated under Complainants' exhibit 135, how long do you think that could be made before a nuisance would be generated in New York Upper Bay?

A. For a long term of years, which I can indicate roughly in reference to the growth of population—to bring about a total population, sewering into New York Bay of fifteen to twenty millions, as I have explained at length, in earlier answers.

212 Q. Do you regard the sewage that will be contributed to the Passaic Valley trunk sewer as a sewage that will be difficult of treatment?

A. In what respect?

Q. In the respects attending sewage treatment in general?

Mr. Riker: The question is objected to as being too indefinite, by an answer of this witness.

Commissioner Maher: The objection will be noted.

A. I don't know of anything extraordinarily difficult about this sewage.

Q. Do you know how many manufacturing plants are along the Passaic Valley that will contribute the oils of their trade wastes to the ten per cent to be accommodated by the Passaic Valley trunk sewer?

A. I cannot tell you from memory; I have studied that matter at great length in earlier years. I assume that whatever the number is, the waste products will be taken care of in the trunk sewer in the manner specified by the plan and by the law.

Mr. O'Sullivan: That is all.

Redirect examination.

By Mr. Riker:

Q. You were asked about the Deer Island outlet in Boston Harbor. Do you know whether that is a multiple outlet or a single outlet?

A. That is a multiple outlet; it has been for a year and a half or more.

213 Q. And with reference to the Nut Island or Peddocks Island do you know what that is?

A. That is a single outlet; there are two pipes, but for each outlet there is a single outlet.

Q. And a submerged outlet, is it?

A. Yes, it is submerged.

Q. Have you examined the waters in the near vicinity to that outlet at Peddocks Island?

A. Not for some years.

Q. And with reference to the population that can be accommodated so far as this sewage is concerned, by the waters of New York Bay, you stated certain elements that would go into the solving of that problem. Did you mention aeration, so far as you remember?

A. I think I unintentionally left it out, and I should have included reaeration.

Q. What part does that play, so far as you are advised in the disposal of sewage?

A. Well, it adds to the capacity of New York Bay for digesting sewage matters through the oxygen it brings into the waters.

Q. I think you testified today that as to the rate of reaeration, you are unable to testify?

A. I have not prepared myself on that particular portion of the matter. I said that Professor Phelps' estimate in my earlier
214 studies looked to me to be very low.

Q. In testifying as to the absence of sludge deposits of ten feet or more on the floor of New York Harbor or New York Bay, have you located the points at which those deposits are to be found?

A. I have made no effort to locate them. I know that there are such in certain of those indentations of the shore line, like Newtown Creek and Wallabout Channel and around slips, but I made no attempt to try and locate them away from the shore lines.

Q. Those are the ones you had in mind, the ones along the shore line?

A. Yes, those are the ones that I had in mind that should be the places for dredging to eliminate that portion of the oxygen consuming properties of sewage as related to the condition of the Harbor.

Q. And these sludge deposits, are they or are they not, as you understand them, located at or about the out-falls of existing sewers?

A. They are so located.

Q. You were asked on cross-examination with reference to the discharge of sewage into Newark Bay. Did you assume a depth of twenty feet as the depth of Newark Bay in your answers to those questions?

A. I assumed a depth of very much less than that of forty
215 to fifty feet, such as in the dispersion area in New York Bay. I really don't recall the exact depth of Newark Bay. I should have said that away from the channel it was much less than twenty feet.

Q. In giving that testimony on cross-examination, as I recall it, you used twenty feet; I ask you now whether you did assume twenty feet as the depth of Newark Bay at any point?

A. No, I did not. If I said twenty feet, I should have said twenty or less. I did not intend to make any specific reference to depth.

Q. Do you know whether the depth at any point in Newark Bay exceeds twelve feet?

(Witness examines map.)

Mr. Riker: What are you referring to now, Mr. Fuller?

A. I am referring to a Government Map issued by the Department of Commerce of New York Harbor and vicinity, and showing in that the depth of water in various waterways. I find that in Newark Bay there is a channel which is dredged to twenty feet, and exceeds that depth in places, but that away from this channel the depths are rarely as much as ten feet, and they are only three or four or five feet in much of the area of the water.

Q. Do you know what the tidal prism of Newark Bay is?

216 A. I cannot tell you from memory; I looked it up in earlier years. I have not studied the Newark Bay matters in connection with this case.

Q. As the point of discharge of an effluent from a sewage disposal plant, Mr. Fuller, in your opinion how does the Newark Bay compare with the New York Bay?

A. It is not nearly as suitable.

Q. Why?

A. On account of the less depth, the smaller velocities of flow created by currents, and the smaller volume of diluting water moving through any dispersion area, and a smaller volume of water would of course bring a smaller quantity of oxygen containing waters to the dispersion area.

Q. You were asked on cross-examination, Mr. Fuller, as to whether or not there might be deposits from the effluent under the stipulated processes, which would be objectionable to the Secretary of War, and whether or not the objectionable deposits would be found if the effuent were discharged into Newark Bay.

A. I was asked such a question, yes.

Q. And do you think that there would be no such deposits?

A. I think there would be no such deposits.

Q. In Newark Bay?

A. In Newark Bay.

217 Q. Do you know what the current movements are in Newark Bay?

A. I cannot tell from memory what they are; I know that they are relatively small as compared with New York Bay.

Q. Does the deposit of matter on the floor of the Bay depend in some degree so far as the sewage effluent is concerned, upon the strength and velocity of the currents?

A. Yes, and I have been basing my answers on the very low velocity to which this sewage flow would be subjected in the basins; that is the very theory of these basins has been to drop the velocity to less than what would be found in the body of water in which it would be discharged. Isn't it a fact that was done so as to meet the conditions in New York Bay rather than in Newark Bay?

A. Yes.

Q. If the velocity of the currents in Newark Bay is very much less than the velocity on New York Bay, might there not be deposits in Newark Bay from the discharge of the effluent therein?

Mr. O'Sullivan: The question is objected to as not being properly a question, but an argumentative statement by counsel.

Commisioner Maher: The objection will be noted.

A. I think that there would not be deposits in Newark Bay,
218 but that is a question which would be controlled by the velocity in Newark Bay in reference to the velocity of flow in the tanks themselves. It is my impression that the velocities in Newark Bay would not fall below those in the basins but I may be wrong. The facts would have to be consulted, perhaps, to an extent greater than I am able to command them from memory. I want to make plain my viewpoints.

Q. Have you in mind any comparison in amount of cubical content of New York Bay and Newark Bay?

A. I cannot state that from memory. The data which I have indicate that the volume of water below mean tide is about 1,542,000 cubic feet out of a total for the Harbor and adjacent waters of 40,971,000 cubic feet; so that there is roughly, below low water, about one-fortieth as much water, and the tidal prism of Newark Bay is roughly ten per cent of the tidal prism of New York Bay and its adjacent waters.

Q. Do these excesses of capacity or content of the New York Bay, as compared with the Newark Bay, have any influence upon the availability of New York Bay as a discharge point of the effluent of a sewage disposal plant?

A. Yes.

Q. That excess, does it or does it not render New York Bay
219 a more desirable point for the discharge of the effluent that would be produced at the pumping station at the Passaic Valley sewerage plant?

A. It does render the New York Bay the more desirable point for disposal and dispersion.

Recross-examination.

By Mr. O'Sullivan:

Q. From what book did you just read volume of water below mean water level?

A. Mean low tide is the figure that I was speaking of, and it is given in part VI of the preliminary reports of the Metropolitan Sewerage Commission, dated February, 1913.

Q. And that body of water remains virtually in the Harbor all the time with the tidal prism sliding backward and forward with the flood and ebb?

A. That volume of water would remain there, but of course it would move out.

Q. Do you know whether it does or not?

A. The upland water surely creates an outward flow of water from the Harbor towards the ocean, and then there is the interchange of those waters as a result of the entrance of new sea water into the Harbor.

Q. How does the upland water go out of the bay, either incorporated with the salt water or on its surface?

A. In times of flood the water is not completely mixed,
220 but there is some fresh water on the surface, but when the Hudson river is not in heavy flood, then the currents and tidal actions generally produce a mixing which is revolved by an approximately equal amount of land water top and bottom.

Q. Have you given any study to the phenomenon of the under run in the upper bay of New York?

A. Yes, I have considered it, but not in the past few weeks; I have looked into that in earlier years. That is not within the range of the particular portion of this order of March 10 that I have been particularly dealing with.

Q. You have testified as to the dispersion that you expected from the peculiarly devised nozzles. I now ask you if the question of the underrun had entered into your consideration of that question of dispersion?

A. Yes, that I have considered, but with less detail than Mr. Sterns who has looked into that matter more than I. I have considered it, though.

Q. Will you state what you understand by the phenomenon of the underrun as found in the Upper Bay of New York?

A. It is the salt water which enters from the ocean and is found in the lower strata of the Bay waters.

Q. How does it enter; describe it as fully as you may, what you understand by that phenomenon of the underrun as found
221 in the Upper Bay of New York, how deep from the surface is it found?

A. That would vary under a wide variety of circumstances. I am speaking of a fact, that you get a greater density of the water—more salt water, in the lower depths of the Bay, at certain seasons of the year than at others, and it is characterized by these salinometer observations that show really more salt at the top than at the bottom.

Q. It enters at the bottom of the channel in the form of a wedge?

A. Yes, it comes in through the Narrows; it comes in from the ocean, and it is, you might say, in the form of a wedge, beginning at the bottom, of course.

Q. And that wedge of salt water enters at the latter period of slack water and pursues its course during the ebb, does it not?

A. During the ebb tide, that is generally true.

Q. And that underrun is found in the bottom of the main ship channel, principally, is it not?

A. Yes, found there more than on the shoals or flats.

Q. And that underrun would be found forty feet below the surface in the main ship channel, would it not, and fifty feet below, where the depths were that great?

A. I should think that would be so. I haven't the detail
222 clearly in mind.

Q. What is the velocity of the underrun?

A. I wouldn't attempt to say.

Q. Can you state any reason why that underrun wouldn't take the sewage discharge that you expect dispersion of, on the latter stage of the slack water, during the full period of the ebb tide, and bring it up around Manhattan Island, even before the ebb had turned?

A. I think that the underrun would move the thoroughly mixed sewage and water toward the north.

Q. So that while the floating matter would be going out of the upper bay and perhaps to sea on the ebb, the sewage from the Passaic Valley trunk sewer outfall would be coming up the river on the underrun?

A. Yes, and mixed with one hundred times or more of water.

Q. How did you locate these sludge deposits in the slips in New York Harbor waters?

A. There is one way of locating them I know about personally, and that is the stirring up which results from power boats and through river traffic going into these slips and making objectionable odors resulting from the mixing up of the solids with the water. That is what was found generally.

Q. That was how you located them?

223 A. I wouldn't say that I have been very prolific in my own observations. To that extent I have seen enough of it, though, I know that that is one of the ways. I also know that these various sounding apparatuses have been utilized by the Metropolitan Sewerage Commission for actually making soundings and bringing up samples for examination under the microscope and things of that sort.

Q. What I am trying to find out, Mr. Fuller, is, whether your observations were from the surface of the water or whether they were aided by any devices that determined the character of these deposits?

A. So far as I have personally made investigations, they were very limited, merely observations from the surface of the water, but during 1913, I had full access to all data of the Metropolitan Sewerage Commission, and I am now making a general statement, having in view all of the information that that commission had at that time and which they put before me.

Q. You have made some statement in relation to the rate of reaeration of waters; have you done any chemical or other work to determine the rate of reaeration in either fresh water, salt water, brackish water, or heavily polluted water?

A. No, I have not.

Q. Have you read Professor Ellery's experimental work along those lines as a part of this record in your studies of this

224 record?

A. Yes, I looked that over some ten weeks ago or so.

Q. And have you read Professor Phelps' testimony on rates of reaeration, which was the result of this direct experimental work?

A. Yes.

Q. As to the general proposition of reaeration, will shallow bodies of water or deep bodies of water reaerate at the same rapid rate?

A. I hesitate to express any very profound opinion on that; I think it is a function of what takes place at the surface of the water, and if wind or currents or mixing effect, as the result of boat traffic, were to stir up currents clear to the bottom, I think that the shallower body of water would get less reaeration than would a deep body of water, but it is not a matter that I prepared myself on for any very profound comment.

Q. Does the reaeration take place at the surface of the water in the first instance and from the air?

A. Yes, but that entrained air perhaps being also a factor, but it is primarily a function of surface action.

Q. And it is distributed to the deeper strata of water by vertical currents, is it not?

A. That is a diffusion of this oxygen from the surface of
225 the liquid down; that is one element, the mixing of the water; the mechanical stirring by the propeller of a boat brings other elements into action.

Q. Are there any vertical currents in the Upper Bay of New York that you know of?

A. I am not informed about it, I presume diffusion would change the constituency of the water, and are taking place. Whatever the laws of diffusion called for I have no doubt they apply.

Q. You understand that the Metropolitan Sewerage Commission performed a very lengthy series of experimental determinations before they were able to estimate the rates of diffusion and dispersion?

A. I understand they made a great many.

Q. Tide experiments and matters of that kind?

A. Yes.

Q. Which of the two bodies of water would reaerate at the most rapid rate, Newark Bay or New York Bay, assuming them both to be very low in their oxygen content at the time that they undertook to rehabilitate by reaeration?

A. Per square foot of water surface, I presume they would be roughly the same, but with a little more opportunity for oxygen to be greater in the New York Bay, but I don't believe I can tell you, without further study and consideration, what that would signify.

Q. You think that New York Bay has greater capacity for
226 reaeration than Newark Bay, do you?

A. Per unit of surface. I think that the percentage of oxygen in the surface water and the effect of winds and currents would be the controlling factors rather than the depth, which I assume you are carrying in your question as the differential element.

Q. Then as I understand your answer, Mr. Fuller, a shallow basin of water has great advantages over a deep basin of water in process of reaeration?

A. I don't think that is the controlling item, with all other factors the same.

Q. What part does sunlight play in the process of reaeration?

A. I don't think that it plays any part directly. Indirectly sunlight might stimulate the growth of some organisms which would release oxygen during sunlight and would consume oxygen at night. I would rather let those two elements offset each other, and I am not taking it into account.

Q. Do not some of those organisms called chlorophyceæ contribute oxygen to the waters in which sunlight can reach them?

A. Yes, that was the idea I had in mind in making my answer to the last preceding question.

227 Q. Would sunlight penetrate deeper into the waters of the Newark Bay than it would into the waters of New York Bay?

A. It would depend upon the relative clarity of the waters; I am unable to tell you from any information that I have at hand about that.

Q. In your studies have you pursued the reports of Birge and Juday on lake waters, on convection currents, on reaeration and on oxygen supersaturation by minute plant life and sunlight?

A. I have looked at it, but not for quite a number of years.

Q. If Newark Bay has not a greater capacity for reaeration than New York Bay, how do you account for the higher oxygen content in the Kill von Kull than at Robbins Reef?

Mr. Riker: The question is objected to because the witness has substantially said that the oxygen content of the Kill von Kull is higher than at Robbins Reef.

Commissioner Maher: The objection will be noted.

A. I do not know; it is a matter that I have not investigated recently.

Q. Do you know whether or not the oxygen content in the Kill von Kull and the lower reaches of Newark Bay are higher than they are at Robbins Reef?

228 A. I haven't any extensive information on that.

Q. You compared the velocities of New York Bay and Newark Bay as to the currents of water; what are the velocities in Newark Bay of the water currents?

Mr. Riker: The question is objected to on the ground that this witness has explicitly said that he does not know what the velocities of the currents of Newark Bay are.

Commissioner Maher: The objection will be noted.

A. I have not studied Newark Bay at all.

Q. What are the velocities of the flood currents of Upper New York Bay?

A. From memory I should say that those velocities in New York Bay are two to three feet per second throughout quite a portion of the cycle, and they of course drop down just before slack water, to less than a foot per second. I think they go to something like four-tenths of a foot per second. The figure that I carry in mind is the one which I think appears in Defendants' Exhibit 5, which states three inches per second as the mean velocity through the vertical section of the Harbor water overlying the dispersion area at Robbins Reef light. That is a minimum.

Q. What is the distance from the Battery to Sandy Hook,

229 Mr. Fulier?

A. My recollection is not very precise on that.

Q. About how much?

A. I should think that is a dozen miles.

Q. Would you say it is sixteen and one-half miles?

A. It wouldn't surprise me; I don't know accurately.

Q. Have you read the Report of Colonel William M. Black, Chief Engineer of the Department of the East, to Leonard Wood, the Major General commanding the Department of the East dated June 22, 1909, as to the matters I am now inquiring?

A. I presume I did at that time; I certainly haven't read it for nearly ten years.

Q. In that report he states the distance from the Battery to Sandy Hook entrance, outer end of Ambrose Channel is about sixteen and one-half miles; do you accept that?

A. I think that is all right.

Q. What is the mean velocity of the ebb current in the Upper Bay of New York?

A. I can make no further statement than to refer to what I have already said, and is the statement on velocities as appearing in Defendants' Exhibit 3.

Q. Can you give me an approximate idea of what that mean velocity would be of the ebb current in the Upper Bay of New York?

A. No.

230 Q. Would you say it was as much as a quarter of a mile per hour?

A. I think the mean velocity would be more than that.

Q. I read from Colonel Black's report:

"The mean velocity of the bay currents is about one-quarter mile per hour."

Do you accept that?

A. I neither accept it nor refute it; it is not a subject I have investigated for a good many years.

Q. What is the duration of the ebb flow in the Upper Bay of New York?

A. I cannot tell you precisely.

Q. Give me an approximate idea.

A. Roughly, six hours; I cannot tell you any closer than that from memory.

Redirect examination:

By Mr. Riker:

Q. Mr. Fuller, is the water of the Thames River at the sewage outfall fresh, salt or brackish?

A. It is brackish.

Q. Speaking generally of the waters of bays into which upland rivers discharge themselves,—fresh, salt or brackish?

A. They are brackish along the seacoast.

Q. You were asked as to the percentage of reduction of putrescible matter recommended by Colonel Black, and I think

231 you said you thought it was about twenty-five per cent.

Mr. O'Sullivan: That question is objected to; this is not redirect, I didn't ask him any questions on recross dealing with those matters.

Commissioner Maher: The objection will be noted.

Q. Are you familiar with the stipulation between the State of New York and the Bronx Valley Sewerage Commission and the United States of America, in the suit pending in the United States Supreme Court, under which that suit was dismissed?

A. I was at the time when that matter was active.

Q. Do you know whether Colonel Black had anything to do with that stipulation?

A. Yes, I know that he was active in that matter.

Q. I read now from Complainants' Exhibit No. 177, in this case, as appears from the record, on page 4318, as follows:

"First. The Bronx Valley Sewer Commissioners at once will begin the installation of a plant for the partial purification of the effluent of the Bronx Valley Sewer System by screening and sedimentation with an efficiency sufficient to remove and which shall at all times remove from said effluent enough of its putrescible contents to purify the same to the extent of ten per cent upon an absolute putrescible scale."

232 Does that refresh your memory as to the percentage that Colonel Black recommended for the purification of the sewage before being discharged into the waters of the New York Bay?

A. I think that is true of the Bronx, but I think at an earlier date he was seeking to get a greater removal of putrescible matter.

Q. Do you know whether he changed his mind or how it happened?

A. He evidently changed his mind.

Recross-examination.

By Mr. O'Sullivan:

Q. Do you know whether he changed his mind, or whether this modification occurred on his recommendations, as his recommendations were excluded and rejected by the Passaic Valley stipulations?

A. I do not know.

Q. In the recommendations for the putrescibility standards and tests submitted to the Passaic Valley Sewerage Commissioners, they were entirely rejected, were they not?

A. I think that is true, for the reasons which I have explained.

Q. And whether the recommendations be made in the Bronx Valley trunk sewer case were modified after he made the recommendations or whether he changed his mind, you don't know,

233 do you?

A. No, I don't but I do know that the difference between thirty per cent removal of total organic matter, which would be naturally expected from past experience, in these sedimentation basins, there is a heap of difference between cutting it back to twenty-five or cutting it back to ten.

Q. Do you know whether or not there are provisions and recommendations for the percentage removal of putrescible matter as the years go on and as other tests are being applied, as this report shows?

A. I think the Federal Government made observations to that effect.

Q. And they started with a ten per cent removal on an absolute putrescible test, and they were to increase that?

Mr. Riker: The question is objected to on the ground that the stipulation itself is the best evidence of its contents and I hand the witness the stipulation and ask him to point out the place at which the provision is to be found.

Mr. O'Sullivan (reading):

"The Secretary of War may from time to time direct such further degree of purification of the effluent of the Bronx sewer not in excess of the findings of the Board, as he may think proper; and within two years after receiving any such direction the Bronx Sewer Commissioners, or their successors in control, shall cause the same
234 to be brought up to the required standard."

Mr. Riker: That is a very different provision from the one stated in the question.

Commissioner Maher: The objection and comment of counsel will be noted.

Mr. O'Sullivan: Read the fourth, Mr. Fuller.

Witness (reading):

"At all times hereafter, through such representatives as he may designate, the Secretary of War of the United States shall have full opportunity to inspect the construction of the proposed purification plant and the condition and working of the entire sewer system, in order to determine whether the terms and provisions hereof are being observed in all respects; and to this end the Commissioners will render such expert or other assistance as he may request. Said Secretary at all times shall have the right to decide whether such terms and provisions are being complied with; and upon notice from him that they are not, the Commissioners or their successors shall forthwith do whatever may be necessary in order to effect compliance herewith."

Q. How many persons were calculated to contribute sewage to the Bronx Valley Sewer?

A. It is difficult for me to recall.

Q. Look under the third paragraph.

A. It speaks of 50,000 people as a figure in excess of the then population tributary to the Bronx Valley Sewer System.

Q. And it is a residential region entirely, is it not?

A. Almost exclusively so.

235 Q. With regard to the London discharge, Mr. Fuller, what percentage of organic matter is removed from the sewage treated?

A. When they use chemical precipitation, I think it approximates fifty per cent; when they use sedimentation, it approximates thirty per cent. I am speaking from memory now.

Q. And after they have purified the sewage, they discharge the purified effluent into the waters at Barking and at Crossness?

A. Yes.

Q. And the sludge which is deposited, they then take out and discharge into the English Channel, do they not?

A. Out into the North Sea; it is not the English Channel; it is some distance east of the mouth of the River Thames.

Q. Some miles out to sea?

A. Yes, some miles out to sea.

236 FREDERIC P. STEARNS, called in behalf of defendants, being duly sworn according to law, on his oath says:

Direct examination.

By Mr. Riker:

Q. Where do you live, Mr. Stearns?

A. Massachusetts.

Q. What is your profession?

A. Civil Engineer.

Q. And included in that term "civil engineer" have you any experience in sanitary engineering?

A. I have.

Q. Where and in what way have you received your education and training as a civil engineer, including sanitary engineering?

A. I did not have a technical education except such as I obtained for myself. I began fifty years ago at work in the city surveyor's office in Boston, and since that time I have occupied various positions from time to time, and acquired my education through experience and study.

Q. Do you hold any college or university degree?

A. I have had some honorary degrees.

Q. Will you name them?

A. Master of Arts, Hartford University; and Doctor of Science, in the University of Pennsylvania.

Q. Will you state your practical experience in your de-
237 velopment as a civil engineer, including sanitary engineering?

A. For three years I occupied minor positions, largely in surveying. Then from 1872 to 1880, I was engaged on the investigation and construction of works for a new water supply for the City of Boston. Beginning in 1880 and extending to the middle of 1886, I was engaged in direct charge of the building of a portion of the main drainage works.

Q. Where?

A. Of the City of Boston. The portion of the work under my direct charge was the Dorchester Bay channel to the Moon Island sewers and outlet. Those works were started on January 6, 1884, and then I was made the executive engineer of the works and had the superintendence of the works under my charge, as well as other matters. From the middle of 1886 until the middle of 1895, I was the chief engineer of the State Board of Health of Massachusetts. In 1886, a law had just been passed giving the State Board of Health charge of the inland waters of the State with reference to the protection of their purity, and also requiring any city or town proposing to introduce a system of water supply or sewerage, to submit its plans

to the State Board of Health for its advice. There was thereafter occasion to pass on all the plans of water supply and sewerage in the State—while I was on that work. Incidently, the Legis-
238 lature used the State Board of Health as a sanitary engineering department, and required it to make various investigations. One of those which were made while I was with the Board related to the North Metropolitan system of sewerage, which has its outlet at Deer Island, and I took some part in that investigation. Another was the investigation for a system of water supply for the Metropolitan District of Massachusetts, and I made that investigation as the chief engineer. I might say that the Metropolitan water supply has cost $40,000,000. Still another investigation made by the State Board of Health and another by the Board of the State, acting jointly, was the proposed Charles River basin, which planned for the building of a dam across the estuary of Charles River, and creating a fresh water basin in a place where the sewage could be wholly excluded. It was very largely excluded, but the overflow of storm water went into this basin, so it brought up, the careful study of the question of the amount of sewage that could be taken care of by a basin with a very small flow of fresh water through it, and depending very largely upon re-aëration.

In 1895 the Metropolitan Water Works were authorized and I became the chief engineer of the Metropolitan Water Board to
239 take charge of the construction of those works, and consisted of dams and reservoirs and such things. I continued on that work until about 1906, when I resigned and that was my last regular engagement. Since then I have been acting as consulting engineer and during the time that I held these other positions I also acted as consulting engineer at times.

In 1888 I was appointed by President Harrison a member of the Board of Sanitary Engineers to devise a system of sewerage for the district of Columbia, and this board of three engineers made a report which was for quite a long time carried out, and this was a plan for the dilution of sewage by discharge into the Potomac River.

In 1905 I became one of the consulting engineers of the Water Supply Board of New York for the Catskill Aqueduct Works and was actively engaged on that work until practically all the plans were decided upon, including the system of tunnels through the City of New York.

In that same year I was one of three commissioners to devise the system of sewage disposal for the city of Baltimore, and that was given out in accordance with the plans recommended. It consisted of an extensive system of sprinkling filters, settling tanks—tanks to supply the effluent from the settling tanks and the discharge
240 into the Back River where the effluent will be further purified by dilution.

I was at a subsequent time engaged by the city of Pittsburgh with reference to a plan of sewage disposal for that City, which had been ordered by the State Department of Health and a study was made for a system of sewage disposal. The chief man on this was Mr. Allan Hazen. I was rather as an assistant to him, and it was finally

decided that the plan which was in operation was the only practical plan—that was dilution.

In regard to sewage matters, I was engaged by the City of Chicago at first in the Federal suit against the City first in connection with the hydraulics of the Great Lakes at the lower end of the lakes, and later in connection with the sanitary matters.

I might say that while I was still with the State Board of Health I wrote a paper which was published in its reports on the pollution and self-purification of streams, as to the amount of water needed to purify sewage.

It has been quoted a great deal and based on very little data.

In other matters than sewage I was a member of a board of engineers for the Los Angeles water supply brought from two or
241 three hundred miles away from the City. And I have acted as consulting engineer on many water supplies and at present engaged on a scheme for Providence, Rhode Island.

In 1905 I was appointed by President Roosevelt a member of the International Board of Consulting Engineers for the Panama Canal. It was the duty of that Board to prepare a plan for the canal, to be carried out by others; and on two other occasions I was appointed a member of a board to go down there and investigate matters that were in question.

I have had to do with city water works in connection with valuations at San Francisco and Oakland and Denver and at Seattle, with reference to a reservoir that wouldn't hold water.

Q. You have been retained by the Passaic Valley Sewerage Commissioners to testify as an expert in this particular suit, have you not?

A. Yes.

Q. When was that retainer made, about?

A. About in the latter part of March or first of April, I think, of this year.

Q. And particularly you have been asked, have you not, to testify as to any practicable plan of sewage disposal or treatment capable of being applied to the sewage of the City of New York and the
242 several boroughs thereof, in order to lessen the alleged polluting effect of the sewage upon the waters of New York Harbor?

A. Yes.

Adjourned to Friday, June 6th, 1919, at 10:30 A. M.

243 United States Supreme Court.

THE PEOPLE OF THE STATE OF NEW YORK, Complainants,

vs.

THE STATE OF NEW JERSEY and PASSAIC VALLEY SEWERAGE COMMISSIONERS, Defendants.

Continuation of Testimony Taken in the Above-entitled Cause Before James D. Maher, Commissioner Appointed by the Supreme Court of the United States, at the Office of Messrs. Riker and Riker, 164 Market Street, Newark, New Jersey, on Friday, June 6th, 1919, at 10:30 a. m.

Present: Counsel as before stated.

FREDERIC P. STEARNS, resumes the stand for further

Direct examination.

By Mr. Riker:

Q. I neglected to ask you about your membership in Societies, Mr. Stearns. Will you tell us what Scientific Societies, if any, you are a member of?

A. I am a member and have been President of the American Society of Civil Engineers, also have held other offices. I
244 am an honorary member of the Boston Society of Civil Engineers, and have been President of that Society, and a member of the American Academy of Arts and Sciences, and some local Societies which do not bear upon this question.

Q. What have you done to acquaint yourself with the present methods of disposing of the sewage by the City of New York?

A. I have examined many of the reports which have been made, particularly those of the Metropolitan Sewerage Commission and the reports of the New York Sewer Plan Commission and the report made by Kenneth Allen, an Engineer, of Sewage disposal of the bureau of Public Improvements, on the dissolved oxygen in New York Harbor in recent years; also examined to some extent his report on the disposal of sewage for the area tributary to Jamaica Bay—that is a part of New York; and I have been through the waters of the Harbor, made a trip, examined the Dyckman street screening plant; that is the greater part of my study.

Q. You spoke of a trip, an inspection trip was that?

A. It was an inspection trip on May 3, 1919.

Q. Will you state where you went and what you saw with reference to sewage disposal of New York?

A. We started from the Battery at about half past ten in
245 the morning and went up the Hudson River, following on first one side and then on the other, as far as the Harlem,

to the East River, down the East River to the Harbor, and across the Upper Bay, past Robbins Reef up to the easterly end of the Kill von Kull, then along not very far from the Staten Island shore, down through the Narrows and to a point about a mile and a half beyond Sea Gate, that is into the Lower Bay; then back on the Brooklyn side, going up through the dredged channel just to the west of Governor's Island and to the Battery. That was the route.

It was noticeable that the Hudson River water was turbid, as the result of the natural flow of the stream rather than sewage. At places near the docks we could observe some signs of pollution by sewage. After passing over to the New Jersey side there were indications of sewage in some places and of some oily sleek. I might say that in many places there was a litter of things that were floating about, wood and rubbish of various kinds. Then we passed into the Harlem River, and this was before the tide had begun to run out of the Harlem into the Hudson, and the waters in the Harlem were also turbid especially for the first part of the course, due to the turbidity of the Hudson water, I judged. I noticed as we passed along
246 that there were some men fishing in the Harlem River. One of my associates remarked that he saw a fish taken out; I didn't happen to look around quickly enough. The pollution was not particularly noticeable in the Harlem at this season of the year, or at least on the day of the visit, but there were some indications of it toward the southeasterly portion of the river.

Getting into the East River the water was clearer, that is, there was evidently less of the Hudson River water there, and as we passed down the East River we saw cases where sewers were emptying close to the shore, some trace of oily sleek, but not very many. The investigation did not go into the docks to any considerable extent. We passed along in the currents. We went across, as I have said, to the neighborhood of Robbins Reef, and saw the location, and then from there toward the Kill von Kull. At that place we encountered a larger amount of oily sleek, between the outlet and Constable Point, than in any other part of the trip, that is, the whole surface of the water in that neighborhood was covered with this oily sleek.

Q. Did you ascertain the source of the oil matter?

A. It appeared to be the oil works in that vicinity at Constable Point. Then going down the shore of Staten Island, toward
247 the Lower Bay, the water seemed to be in good condition, still showing the traces of the turbidity of the Hudson. Coming back on the Brooklyn side there seemed very much more noticeable the effect of sewage as we passed along that channel as it has been dredged down near where the United States Army base terminal is and the Bush Terminal. That was noticeable all along on that shore. There was nothing to remark as to what we saw going up to the Battery.

Q. Did you detect odors of sewage in this trip at any point?

A. No, I cannot say that I did.

Q. What kind of a boat were you in?

A. It was a gasoline motor boat with, say, capacity to carry fifty

or sixty people, I should think. We were some three or four feet above the water.

Q. What did you ascertain as to the methods of New York City in the matter of the disposal of its sewage into the waters of the Bay?

A. That almost without exception it discharges its sewage without any treatment, and in many cases at the shore or bulkhead line rather than at the ends of the piers. I do not know to what extent the sewers have been carried to the ends of the piers, or nearly to the ends, but to a considerable extent.

248 Q. By this method of discharging sewage, from your observation and experience as a sanitary engineer, what is the result so far as sludge is concerned?

A. The usual result is that sludge deposits in the slips between the piers, and it does that to a large extent even if the sewers are carried nearly to the pier head, because there is not a good current of clean water between the outlet and the shore and the material is likely to drift into the slips while the water is comparatively quiet, and under such conditions the sludge deposits.

Q. Do you know whether the Passaic Valley Sewerage Commissioners' plan is in actual operation and discharging effluent into New York Bay?

A. I know that it is not.

Q. From what you have learned by your trip of inspection, and in other ways, will the City of New York within a comparatively short time, establish by its own acts nuisances along its shores?

A. Yes.

Q. Can you make any estimate of the length of time it will take to establish such nuisances?

A. I believe there are local nuisances at the present time in small arms of the Harbor and in the slips between the piers.

Q. Which slips?

249 A. In general, as regards slips; but from what I have read and what I have seen, I hardly see how it could be otherwise.

Q. Where are the local points of local nuisances as you have ascertained them to be now?

A. I have not defined the exact points of these more local nuisances. Remedies have been applied, and whether they have been efficient or not, I do not know, as for instance at the Gowanus Canal, where a pumping plant, costing some $950,000 has been installed.

Q. To do what?

A. To cause a circulation through the canal, drawing in the water from the portion of the Harbor where there are currents, and forcing it out into other parts of the Harbor where there are currents, and in that way refreshing the waters of the canal.

Q. Did you examine the Gowanus Canal yourself?

A. I did not.

Q. Where else are there points of local nuisance established in and about New York, of sewage?

A. There have been such nuisances established in the past that

they called for extensive relief in the Newtown Canal and in Wallabout Bay.

Q. Is that Newtown Canal or Newtown Creek?

250 A. I think it is Newtown Creek.

Q. What about the Harlem River so far as local nuisances are concerned?

A. The Harlem River I regard as more than a local nuisance. I don't think it has reached absolutely that point yet, but it is very close to it. Every report of the engineers that I have read had indicated that the production of a nuisance there is imminent, and that would be my own conclusion from examining the data on which their conclusions are based.

Q. Coming down to the East River, are there conditions there that were observed by you which are tending rapidly to the establishment of a nuisance in the East River?

A. Not that have been observed by me as a physical observation, but that I have deducted from reading the reports of the New York engineers and the studies that they have made. The nuisance there is not quite as imminent as in the Harlem River, but it is so imminent that in my judgment action ought to be taken at once to relieve the conditions; and in that I am referring to the main stream, and not to local troubles that may occur in the slips, but the main stream itself needs relief.

Q. Through what agencies; by the discharge of what sew-

251 age are these conditions produced in the East River?

A. Almost wholly by the discharge of the sewage of the City of New York.

Q. What other element do you have in mind when you use the words "Almost wholly"?

A. The sewage discharged into the Hudson River by the cities bordering directly on it opposite New York would have a slight effect, but not the main effect or any very material effect, because the amount of sewage is so much smaller than from New York.

Q. Do you know what the population of New York is?

A. Only as an estimated population; it is substantially—if I shall continue the answer?

Q. Yes.

A. It is substantially 6,000,000 at the present time.

Q. And what part of that discharges its sewage into New York Bay?

A. Into New York Bay and its various arms, including the East River and the Harlem, I estimate about ninety per cent.

Q. Do you know what the population discharging sewage into New York Bay or the Hudson River on the New Jersey side may be?

A. It is roughly 400,000. I might say that that represents about seven per cent of the sewage of the City of New York, so that the total amount going into the waters of New York Harbor

252 is about three per cent less than the total population of New York.

Q. With reference to the polluted conditions which exist in the New York Bay, to what cause do you ascribe it?

A. Mainly to the sewage of New York.

Q. And to the sewage itself or the method of discharge of the sewage?

A. Mainly to the sewage itself, but the conditions could be improved, if there were treatment before it is discharged. Perhaps that isn't in answer to the question. I may say further the local pollutions, such as occur in creeks, canals and slips, are due mainly to the method of discharge.

Q. Then do I understand you correctly, that you believe that the local nuisances that now exist along the water front are due to the method of disposal of the sewage?

A. Yes.

Q. Can you state the different boroughs that go to make up the greater City of New York?

A. Yes.

Q. What are they?

A. Manhattan is the principal one, Brooklyn, the Bronx, Queens, Richmond.

Q. Which are the heavily polluted and built up sections of New York City?

253 A. The most densely built-up section is the Island of Manhattan.

Q. And what comes after that, in your observation and knowledge?

A. Brooklyn comes next. This is a large territory, but the portion nearest the East River and draining toward the East River is, and also draining toward the easterly shores of the Upper Bay is quite densely built up.

Q. In your opinion will it be necessary for the City of New York to take some decided action in the matter of sewage disposal in the near future, without reference to any contribution to sewage discharged in New York Bay from any other quarter?

A. Yes, sir.

Q. Are you able to determine how soon that necessity will be so pressing that the work must be done?

A. I believe it must be done at once for the Harlem River. One cannot tell in regard to any particular year whether a nuisance will be created just at present, but under unfavorable conditions of hot weather and low flow, I think the Harlem River is likely to reach an intolerable condition any year now, particularly the southeasterly part.

Q. And where is the next most imminent point of danger, in your judgment?

254 A. Referring now only to the larger streams and not to the small parts, the Lower East River, because it receives a very large amount of sewage, a quantity which is increasing rapidly, owing to the growth of Brooklyn, and it is well away from the refreshing influences of the water which comes in from the ocean either through Long Island Sound or at the Narrows. I

don't mean by that that it is so far away, but it is far away when one considers the amount of sewage to be digested.

Q. Have you made any particular examination of the methods of disposal and discharge of sewage, if there are any methods of disposal, for the Borough of Richmond?

A. I haven't given that much consideration, because that is down in a place where it gets the refreshing effect of the water coming in through the Narrows and also the refreshing effect of the water which passes through the Kill von Kull in both directions.

Q. Do you know whether that borough is densely built up or is not?

A. I know that it is not, in the main, the total population now being only in the neighborhood of 100,000.

Q. Are there a number of methods of sewage disposal available for the Borough of Richmond?

A. Yes, but the opportunity of a disposal by dilution is such that I have not made any particular study. I know that
255 plans have been made by which the sewage may be collected and treated from portions of that borough so as to remove some of the solid matters before discharging the sewage into the tide waters.

Q. In your opinion is that or is that not a proper method of disposing of the sewage of the Borough of Richmond?

A. I believe it is a proper method as soon as the necessity arises for making the change.

Q. Making a change from what Mr. Stearns?

A. From the direct discharge into the tide waters about the Bay. It is one of the things that can be done to lessen the polluting effect upon the waters of New York Harbor.

Q. Now, coming to the Hudson River side of Manhattan Borough, what methods of treatment are available for that portion of New York City which will result in lessening the polluting effect of the sewage on the waters of the Harbor?

A. The most feasible method in my opinion is the extension of the sewers to meet the head of the piers, so that the discharge will be into the main current, and there will be a current of clean water between the ends of the piers and the outlets of the sewers. Now, in connection with that it is very desirable that the sewage be screened,
especially for this reason, that the sewers generally are short,
256 the sewage comes in a very fresh state to the Hudson River and there are many lumps of excrement in it which will float to the surface and give the indications of the sewage discharge if it is not screened.

Q. So far as objectionable local conditions about the slips and pierheads, what effect will the treatment that you suggest or the disposal that you suggest, have upon these conditions?

A. I think it would improve those conditions very much, indeed, because a discharge well out into the current will cause a great dispersion of the suspended particles through the currents which get out there, so that the dispersion will be so wide that there should be no accumulation of sludge deposits to any considerable amount. The

complete remedy at that place would mean only to dredge out the deposits which have gathered in those slips.

Q. You are now speaking of the remedy of the local conditions, are you?

A. Yes, the remedy of the local conditions which would have a marked effect on the condition of the Harbor as a whole, because those deposits would not draw upon the digesting capacity of the Harbor if they were removed.

Q. What do you understand to be the digesting capacity of water so far as sewage is concerned?

257 A. Practically the amount of the dissolved oxygen which it contains, that is, where there is dissolved oxygen in water, decomposition goes on of a kind that is inoffensive; that is organic matter, the carbon hydrogen and nitrogen of the organic matter is turned into—is mineralized, as the term is often used, the hydrogen uniting with the oxygen, becoming water; the carbon uniting with oxygen, and becoming carbonic acid, and the nitrogen uniting with oxygen and becoming nitric acid, which in turn at once combines with some base to make a nitrate. All of those things are inoffensive.

Q. Do you know whether the City of New York is applying the methods of disposal which you have suggested with reference to Manhattan shore of the Hudson River, at any point on that shore?

A. It has introduced a screening apparatus at the Dyckman sewer outlet with a grit chamber, and when I visited that place there was a pipe on the ground that was to be laid, to carry the sewage out to deep water, but up to that time it had not been laid. That was May 3rd. I think my trip around the Harbor was taken May 2nd instead of May 3rd, as I have stated, and this was May 3rd.

Q. Do you know whether there is at any other point along the Manhattan shore of the Hudson River any treatment or disposal plant of the character of the Dyckman street one, either in

258 existence or contemplated?

A. I have heard that one is contemplated, but I do not know of any of the developments.

Q. Do you know whether any other exists as a matter of fact?

A. I believe that no other does exist.

Q. Have you any information in regard to the oxygen content of the waters of the Hudson River about the Manhattan front?

A. I have examined the records as given in the Metropolitan sewage reports and also as given in the report of the Chief Engineer of the Board of Estimate and Apportionment for the year 1917.

Q. At what point of percentage of saturation do you place the safe margin of dissolved oxygen in the waters of the New York Bay?

A. As far as I am acquainted with the city—and I think I am fairly well—there is no danger of offensive conditions as long as there is any dissolved oxygen in the water, but it could not all be brought down to that state; there must be a margin, and I should say in the neighborhood of thirty per cent of saturation was a safe limit.

Q. Will the methods of disposal of the sewage which now discharges on the Manhattan front and Manhattan shore of the
259 Hudson River, the method of disposal suggested by you serve to satisfactorily take care of the sewage so that offensive conditions will not arise for some time to come if applied?

A. I believe that they will. That question carries with it what is done to other places to some extent, but assuming that there are places where there will be a necessity for taking care of the sewage, are properly attended to, then I believe that the methods that I have suggested for the Hudson River will apply for practically all time.

Q. In the matter of the extension of the discharge and outfall pipe to the current into the deep water and from the pierheads, do you contemplate single discharge outlets or multiple discharge outlets?

A. That would be rather a matter of detail. If single sewers were to be discharged which do not bring much sewage, a single outlet would be sufficient. If they are to be collected together, so as to use one outlet for several sewers, it might be advisable to use multiple outlets. Multiple outlets should be used if the quantity of sewage is large.

Q. Turning to the problem presented by the polluted condition of the Harlem River, Mr. Stearns, what plan for the correction of these conditions have you to suggest?

A. In that case it would not be sufficient to extend the
260 sewers out into the river, because the whole body of water is nearly devoid of oxygen in the hot weather of summer, and in times of low flow in the Hudson River, and therefore it is necessary to take the sewage away from that stream and to take it to places where there is more oxygen available for the digestion of the sewage.

Q. Do you know, Mr. Stearns, whether the territory that drains into the Harlem River is one where considerable growth of population has taken place?

A. A large growth of population has taken place in past years. I do not know personally to what extent the upper part of Manhattan is built up as to population, but sewage is also brought into it from the Bronx, which is growing rapidly.

Q. So that you have said, I think, that it is your opinion that it will not be feasible to improve the conditions in the Harlem by screening and extending of outlets into the deeper water of the Harlem as you suggested with regard to the Manhattan front of the Hudson River?

A. Because, if you wish the reason, there will be more growth of population, for one thing but also there is less capacity there for digesting sewage.

Q. Have you any knowledge of the conditions of the Harlem River so far as oxygen content is concerned?

261 A. As I have seen it in the reports, it has in extreme occasions, reached zero, and has an average during the summer months, by an average of fourteen observations at two points, in

one case case thirteen and the other case nineteen per cent of saturation.

Q. What method of disposal of the sewage that discharges into the Harlem River have you to propose or suggest?

A. There are two methods that may be considered: One, the diversion of the sewage westerly into the Hudson River, where there would be very ample oxygen, during a very large part of the year, and probably sufficient for a good many years to come in the dryer parts of the year; and another method is diverting it easterly toward Long Island Sound. Those are the plans that appear to be most available for the present time.

Q. Taking the diversion to the Hudson River, Mr. Stearns, does that involve any sedimentation or treatment of any kind?

A. Yes, the plans have been prepared or have been suggested by the New York—— I would like to modify that; a plan was suggested in 1914, by the New York Sewer Plan Commission, which involved a diversion of sewage from Manhattan westerly into the Hudson River and its sedimentation works, and screens before being discharged into the river, but that would be a desirable plan
262 to adopt; that is in order not to overtax the river, it should be settled and screened.

Q. You say from Manhattan; you mean the discharge into the Harlem River from the Manhattan side should be so treated?

A. Yes; that is, the sewer that now runs from Manhattan into the Harlem River should be diverted from the Harlem River and so treated, and also the sewage coming from a portion of the Bronx.

Q. With reference to the other plan, what is that?

A. It is a plan, or a modification of a plan, proposed by the New York Metropolitan Sewage Commission for collecting the sewage which now discharges into the Harlem River and also the sewage from a considerable additional territory, and carrying it to sedimentation works at Ward's Island. The point is not near enough to the East River, or rather to Long Island Sound, to make it entirely acceptable, and the further suggestion has been made that an outlet be made at Riker's Island, which is about three miles nearer the Sound; that would be a better suggestion.

Q. Does that plan involve treatment of any kind?

A. Yes, screening and sedimentation; and looking into the future, still further treatment to produce a more nearly clarified effluent.

Q. What further treatment is there suggested, looking
263 further into the future, than the sedimentation and screening?

A. I am speaking now of the suggestion made by the Metropolitan Sewerage Commission, and I think that covered some chemical treatment.

Q. In your opinion is that plan practicable?

A. The plan of plain sedimentation is a practicable plan to cover a reasonable time in the future.

Q. Does the discharge from the treatment works that are completed or suggested involve multiple outlets in deep water?

A. Yes.

Q. Going back, I will ask you whether the proposed suggested plan of taking the sewage to the Hudson River is in your opinion practicable?

A. Yes.

Q. I think you have testified to conditions that are developing in the East River at its lower end?

A. Yes.

Q. What plan have you in mind or can you suggest for relieving the conditions which are developing there?

A. The relief of that place must be had, in my opinion, by taking the sewage in a southerly direction to portions of the Harbor where there is a surplus at present of dissolved oxygen, or to the
264 ocean, that is, it may either be carried down—strike that out—the nearest point which I would suggest is south of Governor's Island, at a place suggested by the New York Sewer Plan Commission, and it would be better if it were carried further down, where it would get more of the refreshing waters that come in through the narrows, and the further it is carried, the better the results would be, in regard to getting out of the part of the Harbor where the dissolved oxygen is becoming deficient.

Q. What method have you to suggest with reference to gathering together the sewage and taking it to some such point, either below Governor's Island or further down the Bay?

A. Take first the plan of the Sewer Plan Commission.

Q. I want you, if you please, to make your suggestion.

A. My suggestion would be to take the sewage by means of an intercepting sewer built along the Brooklyn side of the East River and the Easterly side of Buttermilk Channel to Red Hook, and from that point to run to an outlet south of Governor's Island, the outlet to be carried out far enough to reach deep water. The question as to just what treatment should be given to that would require some study. There are two alternatives: One is to construct an island south of Governor's Island and build on it sedimentation works, and
265 after screening and sedimentation, to discharge the sewage through multiple outlets into the easterly side of the main channel. That would utilize this point of disposal to the greatest extent—practically to the greatest extent, that it would be practical to utilize it. Another suggestion is this, that an outlet at the place suggested should be considered somewhat tentative, and consist only of an outlet discharging at that place without the building of the island and sedimentation works, with an idea of carrying the sewer further to the south, to a new point of disposal as soon as the digesting capacity of that part south of Governor's Island has been reached. Either of those two plans would be practicable.

Q. An immediate plan, in any event, is the discharge through multiple submerged outlets at or off Red Hook, of the sewage that is now discharging into the East River from the Brooklyn side?

A. Yes.

Q. The second plan contemplates that at some future date an extension of the main trunk sewer might be made further south or east?

A. South.

Q. Into the waters nearer the lower Bay?

A. Yes.

266 Q. What suggestion can you make as to the disposal discharge of the Sewage that now comes into the East River from the Manhattan side?

A. That would depend upon whether it were found by detailed studies to be better to adopt first the plan which I have suggested, of an intercepting sewer only on the Brooklyn side, which would take away about 150,000,000 gallons of sewage every day and relieve the lower East River for a time, or whether it would be better to arrange to take away a larger quantity, in the first instance, so as not to have to make a change in the system at as early a date. If it were found advisable to take away this larger quantity of sewage, that is, both that, that enters from the Brooklyn side and that that enters from the Manhattan side, that can be done by building intercepting sewers on the Manhattan side and a tunnel across the river to convey the sewage to this main sewer extending to Red Hook. That would be a more complete relief to the lower east river, which of course would have its effect upon other parts of the Harbor.

Q. Which suggestion, in your judgment, is the proper one for adoption?

A. It is largely a financial question. I think it would be propriety to adopt the smaller plan first, because the connection

267 across the river could be made at a later date.

Q. You have spoken of multiple submerged outlets at two points, Mr. Stearns, one in connection with the discharge of the Harlem River sewage into the East River, and the other, the discharge of the sewage from Brooklyn which now goes into the East River, at or about Red Hook. What advantage do you know to be caused by the discharge of sewage or effluent from sewage into waters of the Bay from multiple submerged outlets?

A. I know this, that where the sewage is discharged in deep water through multiple outlets, it is feasible to accomplish a mixing of the sewage with the water to such an extent that it is no longer sewage, that is, it is a water which contains the suspended particles of sewage to the extent that they are discharged into the tidal waters, but it contains sufficient water, and I am assuming that there is dissolved oxygen in the water to entirely purify by inoffensive methods, the mixture.

Q. What is the simplest form of sewage disposal in actual practice, Mr. Stearns?

A. By dilution, and generally by turning sewage into a stream at the shore line and at the surface.

Q. Dilution you say, is the simplest form of treatment?

A. Yes.

268 Q. Where is such treatment in operation; under your personal observation, where has it been?

A. In many places. I have had occasion to know of its use in many places, but the principal place, the one that furnishes the best

basis for an opinion as to the effect of such disposal in New York Harbor, is furnished by Boston Harbor.

Q. What opportunity have you had for observing the operation of that form of disposal in Boston Harbor?

A. I was in direct charge of the Moon Island works for two and one half years after it was first built, and I frequently visited those works since that time. Then I knew about the plans and the reasons that effected the design and location of the Deer Island outlet as it was originally built. At the Nut Island outlet I made a special study of the results, for the reason that that furnished the best basis for forming an opinion as to an improvement of the outlet at Deer Island. That matter was referred by the Metropolitan Water and Sewerage Board to two consulting engineers, one of whom was Mr. Hiram F. Mills, and the other myself, and we made that study of the Nut Island outlet as a basis for the design of the improved Deer Island outlet which has since been built.

Q. When was that built and put into operation?

A. December 1917, that is the date of operation.

269 Q. Has it been operating under your inspection from time to time since then?

A. I have inspected it on two occasions.

Q. What population does the Moon Island Discharge serve?

A. 402,000.

Q. 402,000 population?

A. Yes.

Q. That is Moon Island?

A. Yes.

Q. At what point, with reference to the surface of the water is the discharge made?

A. Directly at the surface. Perhaps I might explain: Directly at the surface, there are two sewers side by side, each about twelve feet in diameter, and with their bottoms, I think, about eight feet below the level of high tide. Just about at the level of low tide, so that it is practicaliy a discharge directly at the surface.

Q. Is the discharge continuous or intermittent?

A. The discharge is intermittent, owing to the location of the outlet and the information available in 1880 of thereabouts, when the works were designed, it was thought necessary to stid the sewage during the latter part of the outgoing tide and the whole of the incoming tide, that is for a period of over ten hours, and to dis-

270 charge it in the beginning of the ebb tide, so that it would be carried a long distance out to sea and not come back aga'n into the Harbor. The results are entirely effective, as far as carrying out to sea and disposing of it was known from appearance later, but it produced a very offensive condition at the outlet, because of the nature of the discharge, the great quantity of discharge and the fact that it is discharged directly at the surface.

Q. What is the average sewage discharge at Moon Island?

A. That is rather hard to tell, because there are many sewers near Boston of the old construction where the sewage stands there and gets out very gradually, but it must take a good many hours for it to

reach the pumping station and to be pumped over to the Moon Island. And there it is stored anywhere from ten hours to the time it is discharged. That is, some of it has of course been there ten hours in the reservoir, and others not at all, an average of five hours. It is thoroughly septic at the time it is discharged.

Q. You haven't any method of determining the age of the sewage, including the length of time it stands in the detention basins, the age when it is discharged on the surface of the Boston Harbor?

A. No, I should think it would be about the same time as
271 is required for the sewage to come down from the Passaic Valley. It is about the same length of sewers, and in addition there is the time of storage in the Harbor, and the effect of these flat sewers in Boston with many deposits in them, the old time sewers that have not been rebuilt.

Q. Mr. Stearns, what population does the Nut Island sewer serve?

A. 491,000.

Q. At what point does that sewer or those sewers discharge with reference to the surface of the water?

A. There are two main outlets, and a third one used only in case of storm. The two outlets are—I will state it from memory, and I think correctly—twenty-four and thirty feet, below, low tides.

Q. That is, the two outlets?

A. Yes. As a rule, only one is used at a time, and when I have examined the discharge of sewage at this outlet, the one that was thirty feet below the surface was in use.

Q. In what direction is the sewage discharge from the outlets in question?

A. The outlet pipes are five feet in diameter, and this is turned by means of a quarter bend, so that it points directly to the surface.

272 Q. It is a vertical discharge, then?

A. Yes.

Q. What is the furthest point of origin of any sewage which discharges at Nut Island?

A. I can only give that as a rough estimate. I think it must be more than twenty miles, but in this case there is not the trouble from the old sewers that there is in the case of the Boston main drainage works; the sewers are generally better built.

Q. Is that a continuous or an intermittent discharge?

A. Continuous.

Q. Is there any treatment given to the sewage before it is discharged at that outlet?

A. Practically none.

Q. When you say "practically," what do you mean; is there any?

A. Yes.

Q. What?

A. They have some coarse screens; I think the bars are about an inch apart, and they take out the coarse matters, very coarse matters. There was on the line of the sewer a grit chamber, but the use of it has been abandoned. So that practically everything, except some

bits of paper and other things that are caught by the coarse screen, is discharged at the outlets.

273 Q. What is the result of that discharge so far as objectionable conditions produced thereby, as compared with the Moon Island discharge?

A. It is not nearly as objectionable. The Moon Island discharge is extremely objectionable because the sewage which is nearly two and one half per cent lighter than the water into which it is discharged, is discharged at the surface, and being so much lighter, than the Harbor water, it spreads out over a great area, more than a square mile. It is offensive sewage and is very disagreeable and not in the least comparable with the conditions which would exist with a deep outlet and a multiple outlet.

Q. Compare it with the Nut Island outlet?

A. As compared with the Nut Island outlet, it is very much worse than the Nut Island outlet. The Nut Island outlet gets a very considerable mingling, notwithstanding that it is only a single outlet, five feet in diameter, with the harbor water as it rises to the surface. I have made examinations to show the extent of the mingling,—and hence it is largely harbor water at the surface; it doesn't have a strong odor, and under most conditions it cannot be seen very far from the outlet, except that the slight sleek can be seen fur-

274 ther than the sewage itself; that is, it has not caused offensive conditions.

Q. I think you have given the population served by Moon Island and Deer Island Sewers as substantially the same?

A. There is the difference between 402,000 and 491,000.

Q. 491,000 being the Nut Island discharge?

A. Yes.

Q. 402,000 the Moon Island?

A. Yes.

Q. Coming to Deer Island, what population do the sewers that discharge there serve?

A. 646,000.

Q. The original outfall consisted of what?

A. It was a pipe turned up by means of a quarter turn; I think it was a little over six feet the diameter and it was located just below low tide, about a foot or two.

Q. Can you state approximately the longest distance which any sewage discharged through that outlet comes?

A. Only as a guess, about thirteen to fifteen miles.

Q. As a guess, what is the basis of your guess; have you any knowledge of the subject?

A. I have knowledge of the places that it comes from, but I never measured the distance.

Q. Is your statement anything better than a guess, then?

A. I should say it was an estimate, but I should be gov-

275 erned by the facts rather than my statement, if anybody has made a measurement of it.

Q. Mr. Stearns, you testified that through a commission of which you were a member, a change was made in the outlet of the Deer Island sewer outfall; why was that made?

A. The sewage was discharged at the surface by the old outlet, or practically at the surface, and it produced offensive conditions, although to a very much less extent than the Moon Island outlet, for the reason that this was a continuous discharge and it was thought desirable to produce a better condition at the outlet.

Q. What did the commission do in order to produce a better condition at the outlet?

A. It extended the existing outlet 315 feet carrying it from the shallow water at the edge of the channel into deep water on the side and easterly portion of the channel. In that length of extension there was a length of 119 feet which was more than thirty feet below low tide, and in that 119 feet, an arrangement was made of thirteen multiple outlets and also an outlet was left at the end of the 119 feet, making fourteen in all.

Q. When you say thirteen multiple outlets, do you mean that each outlet was a multiple, or each outlet was single?

A. Thirteen single outlets I should have said.

276 Q. What is the diameter of the outlets in question about?

A. They are not round and they are not of the same size in each case. I have a record here of two of them, and that I think would show about the size.

Q. Made by yourself?

A. Yes, I assisted in the making of this plan. One of those is seventeen inches high and thirty inches wide, another is nineteen inches high and thirty-three inches wide. They discharge about horizontally.

Q. There are thirteen of them and with the end discharge at the end of the pipe, there are fourteen discharges all told in this Deer Island improved outlet, of outfall?

A. Yes.

Q. And the discharge, I think you have said, is thirty feet below the surface?

A. The first of those outlets is thirty feet below low tide, and the deepest one fifty feet below low tide.

Q. What conditions have been created by the improved outfalls of the Deer Island outlets?

A. They have removed substantially all of the offensive conditions that existed there before, and they have produced a mingling of the sewage with the salt water, at the time this mixed water comes to the surface, of an amount that is about twenty times. The first examinations that were made there, in which I took part,

277 were last year, and the minglings at that time, as shown by the chlorine content, was thirty times as much sea water as sewage, at the time it reached the surface, and this was done at dead low tide. Some more recent examinations made during the past month, only on one occasion, did not give as good results and didn't seem as accurate, but taking them all together, I am calling it twenty times dilution; that is, each part of sewage is mixed with twenty times its volume of harbor water.

Q. Is that mixture sewage or what is it?

A. By the time a mixture of that kind is reached, it practically is

not sewage. May I add this, that 300 feet away, from the outlet, on this first occasion, we found that the sewage was so completely mixed with the Harbor water that we couldn't detect,—there wasn't an infinite amount of mixture.

Q. You don't mean an infinite, you mean infinitesimal?

A. Yes, I mean it showed one hundred per cent salt water, and hence it seemed to be an infinite amount, but I don't think our examinations could be depended upon to that extent, as it was at least mixed with one hundred times its quantity of harbor water.

Q. The conditions that exist so far as sight and smell are concerned, at the Deer Island outlet, are they objectionable or unobjectionable.

A. I should call it unobjectionable at the present time. There is an opportunity to get the odor of sewage if you are directly
278 over it in a small boat, but it will not be noticed, in my judgment, by people who are passing and didn't have their attention called to it, and it disappears very quickly.

Q. Have you any knowledge of the plans for the dispersion area of the Passaic Valley sewer at Robbins Reef?

A. I have.

Q. What does that consist of?

A. There are six parallel lines of pipes, each 100 feet apart, 100 feet from one another, each containing diffusion nozzles at intervals of about ten feet; also some diagonal lines, and in the top of these are there diffusion nozzles to the number of 150. If I were to make a comparison with the outlet at Deer Island, there is 1,000 feet of pipe with diffusion nozzles, as against 119 at Deer Island. There are 150 nozzles at Robbins Reef, in the Robbins Reef plan, as compared with fourteen at Deer Island, and those nozzles instead of sending the sewage out in a uniform solid stream, as at Deer Island, are ingeniously arranged so that the sewage is sent out through a diverging angular space, and by means of a spiral diaphram. That water, which is only two inches in thickness at the point of dis-
279 charge, will have this swirling motion, and also this outward motion, by reason of the conical shape of the discharging outlet, so that Harbor water there or Bay water will be entrained by the moving stream of sewage, and I know that it must produce a mingling of sewage, and whether that is many times—well, very much greater than that at Deer Island.

Q. Mr. Stearns, is the sewage discharged at Deer Island subjected to any treatment before being discharged?

A. It passes through some coarse screens at the pumping stations; otherwise, there is no treatment.

Q. Is that treatment designed to prepare it for pumping, or is it designed to accommodate some other purpose?

A. It is designed only to keep the large substances from going to the pumps.

Q. When you suggest multiple submerged deep outlets at the discharge points of the intercepter leading from the Harlem River section, and also for the Red Hook, also for the intercepter taking the

sewage from Brooklyn, do you contemplate such a system of dis-
person as is applied in the Passaic Valley sewerage plan?

A. Yes, substantially that.

Q. In your judgment will there be objectionable local conditions created in the East River or off Red Hook, if those plans are adopted?

280 A. No.

Q. Will there be a sewage field established at those points?

A. I do not think there will, at certain portions of the year, during a large part of the year. I am quite sure they will not be, because the conditions of gravity will not permit the sewage to come to the surface. I am referring now to the fact that the surface water is lighter than the mixed sewage and the bottom water, during a great part of the year.

Q. Now, if the plans that you have suggested for the different sections of New York City are put into practical operation, for how long a period do you think that objectionable condition will be eliminated in the waters of New York Bay or Harbor?

A. I think I will have to take that in detail rather than as a general statement. The data are rather uncertain. Taking the waters of the Harlem westerly to the Hudson would, I think, hardly be as permanent a plan as taking it easterly toward the Long Island Sound, and therefore I will refer to the latter plan. I will have to give the best judgment I can, as rather an offhand judgment, and I should think that treatment at Ward's Island, or still better at Riker's Island, would last for twenty years without any further—that is, it would offset the difficulties arising from the growth of popu-

281 lation in New York for twenty years.

Q. That is, so far as the Harlem discharge is concerned?

A. Yes.

Q. What about the East River discharge?

A. The first plan suggesting the discharge south of Governor's Island, I should think would last from—I will give a range of figures—from thirteen to twenty years. The location there is not particularly good, because it is pretty near the mouth of Buttermilk Channel, and that is to an extension of the Lower East River, so that at times the water of the East River will come down there, and at other times some of that sewage would go back toward the East River, but by making that a tentative plan for thirteen or more years, the extended plan down toward the Narrows would probably meet all requirements for twenty-five or thirty years.

Q. And the disposal proposed for the Manhattan shore of the Hudson River I think you said was practically permanent?

A. Yes, if other parts of the Harbor are taken over, that might be permanent—would be permanent.

Q. Do you know whether any of those plans are under consideration by the authorities in New York?

A. Yes, I have already stated so, I think, with regard to the diversion to the Hudson River and the diversion to Ward's

282 Island, and there is a plan in existence for carrying the sewage from the Brooklyn side of the East River to a proposed

island south of Governor's Island and discharging it into the deep water there.

Q. Are those plans practicable, in your judgment?

A. Yes.

Q. Do they involve prohibitive costs?

A. No, sir, the cost would be very low in proportion to the size of the City of New York.

Q. Mr. Stearns, the outfalls which you have testified to in Boston Harbor are all located in the outer Harbor, are they not?

A. They are located at the dividing line between the inner Harbor and the outer Harbor, as it is sometimes called.

Q. How far are they located from the main shore?

A. The one at Moon Island is directly at the shore; the one at Deer Island, the original outlet was about—I think it will be near enough to say 2,000 feet from the shore, and the new Deer Island outlet is about 200 feet further out from the shore.

Q. The Nut Island?

A. The Nut Island is a mile from Nut Island and about a quarter of a mile from Peddock's Island.

Q. How far from the main shore?

A. The nearest point on the main land would be a mile and one-third.

283 Q. How far is Moon Island from Deer Island?

A. About two miles.

Q. And Deer Island from Peddock's Island?

A. I think that is about two miles. Those are from estimates and not measurements.

Q. Have you taken into consideration the ultimate disposal of New York sewage?

A. Yes.

Q. Beyond what you have testified to?

A. I have.

Q. Where do you place that ultimate disposal?

A. It should be into the Lower Bay or the ocean.

Q. For what population do you think it would be necessary to make that provision, other than the plans which you testified to?

A. I believe that the ultimate population that could be taken care of by all the waters of New York Harbor is in the neighborhood of 15,000,000; that is a round number.

Q. When you say "taken care of," what do you mean?

A. I meant that the Harbor would have a capacity to digest the sewage of 15,000,000 people, if it could be fully availed of.

Q. When you speak of the Harbor what do you mean?

A. I am speaking of everything between the Narrows and

284 Throggs Neck.

Q. Upper Bay, you mean?

A. It would include the Upper Bay and East River and Hudson River. All of the waters between the Throggs Neck, or Long Island Sound and the Narrows, at the southerly end of the Upper Bay.

Q. You testified that a population of 15,000,000, if the oxygen

content is fully availed of, would be successfully taken care of, so far as sewage is concerned, by that water?

A. Yes.

Q. After you pass that limit of 15,000,000, do you think it is necessary then to make an ocean disposal?

A. I think it may be feasible and wise to do it long before that, for the reason that it may be cheaper to make the ocean disposal than to attempt to utilize fully the digesting capacity of New York Harbor within the limits which I have stated.

Q. Where do you place your point of ocean disposal, Mr. Stearns?

A. I think the best place is south from Coney Island and taking into account cost of Construction and safety of the works, on the inner side of the bar, into deep water through multiple outlets.

Q. Does that plan involve any treatment?

285 A. No, I think there is no occasion for any treatment whatever if sewage is discharged into the Lower Bay.

Q. Is that plan practicable?

A. Yes.

Q. Prohibitive in cost or not?

A. Not at all prohibitive in cost.

Q. Have you made any estimate of the probable cost of such a disposal?

A. I have adjusted an estimate, that is published by the Metropolitan Commission, and believe that it could be accomplished on the basis of an adjustment of that estimate, leaving out items which they have included, at a first cost of about $15,000,000.

Q. That is an ocean disposal?

A. An ocean disposal. That is, I would omit many features of the plan for an ocean disposal proposed by the Metropolitan Sewerage Commission.

Q. Do you know whether the point of discharge which you have in mind is within the territorial limits of New York or not?

A. I do not know for certain. It would be north of the Ambrose Channel, and I presume—or northwest—that it is within those limits, but I do not know.

Q. What part, if any, of the plans suggested by you for a more temporary disposing of New York sewage, is actually in

286 course of construction, constructed or authorized.

A. I do not know.

Q. Do you know whether any part of it is actually constructed?

A. I do not; I have heard some statements, but it is so indefinite, that I cannot claim any knowledge on the subject.

Q. What about the Dyckman Street works?

A. The Dyckman street works, the screens are built and so they can be operated; they were operated to show me how they went, and the outlet is not yet built, or was not on May 3rd.

Q. Do you know of any other works, of these that are described and recommended or suggested by you, which are even started?

A. I do not.

Q. Did you observe any on your inspection trip?

A. No.

Q. Have you learned of any from the reports to which you have had access?

A. But I should add to that last statement, that I have not seen any recent reports of the sewerage of New York, that is, within the last year or two, except the one relating to Jamaica Bay.

Q. There is one question that I omitted to ask you, which
287 I desire to ask, in reference to the comparative size of the streams of discharge from the multiple outlets at Deer Island and those which will be discharged from the nozzles on the Passaic Valley system.

A. The nozzles on the Passaic Valley System at the point of discharge have an outside diameter of twenty-eight inches and an inside diameter of twenty-four inches, so that the area is substantially a square foot.

Q. That is, the area of actual liquid, you mean?

A. Yes, but it is seventy-two inches in length and two inches in width, so that it is a very fine stream. The one at Deer Island is about three square feet and is a solid stream, which makes a very great difference in the effect; that is, the difference between a solid stream and a narrow ribbon of water, especially as the narrow ribbon of water is to have this outward and swirling motion. The feature that is necessary is the mixing action; that is what is aimed at, and the relative areas would give no relative idea of the mixing action of those two nozzles; while the area is in proportion of one to three, the mixing action would be nearer one to fifteen.

Q. The lighter sewage effluent discharge through the nozzles in the Passaic Valley plan would or would it not be equally diluted with the heavier waters of the Bay, and thus be prevented from rising to the surface?

288 A. It would be diluted very quickly, and as a result of that dilution the mixture would at once take substantially the specific gravity of the bottom water. Under average conditions there is about forty-five per cent of land water at the surface at Robbins Reef and thirty-three per cent near the bottom. That is the result of many determinations which have been made. Now, the specific gravity of the water at the bottom into which the sewage is discharged is 1.67 per cent greater than that of fresh water. The sewage is practically the same specific gravity as fresh water. If that is mingled in the proportion of one part of sewage to one hundred parts of this bottom water, the specific gravity of the mixture will be 1.65 per cent greater than that of the fresh water. But supposing no better results are obtained than are obtained at Deer Island, which is a mixture of about twenty times, the specific gravity of the mixture would be about 1.57 per cent more than fresh water. Now, even with that smaller mixture the specific gravity of the mixture would be 1.57 as against 1.37 for the surface water; hence it would not rise, because gravity would hold it down. That is a condition which does not exist at Deer Island or Nut Isand. The water has the same per cent of land water both at the top and bottom

in those places, and it is very small. There is a distinct
289 difference.

Q. Then the conditions which prevail in that respect in New York Bay are more favorable for the prevention of the rising of this diffused sewage effluent to the surface?

A. Yes, it will prevent it during a great part of the year, so that nothing in the way of sewage will be seen at the surface, in my judgment.

Q. Would that same condition exist at the suggested outfall of the river and off Red Hook for the New York sewage?

A. It would exist off Red Hook. I am not quite so sure as to its existing at the East River; it would exist to even a more marked extent in the Hudson.

Cross-examination.

By Mr. O'Sullivan:

Q. Did you ever, Mr. Stearns, make oxygen or bacteriological determinations at any time in the waters of New York Bay or the East or the Hudson or the Harlem Rivers?

A. I never made any personally anywhere; I am not a chemist or bacteriologist.

Q. I understand you did not graduate in chemistry?

A. No.

Q. And you did not graduate in bacteriology or biology?

A. No.

290 Q. And you did not graduate as a civil engineer?

A. No.

Q. What is the volume of sewage discharged into Boston Harbor from Boston?

A. I cannot answer that question exactly, because there are three different outlets and Boston discharges in part through each one, if you mean from Boston proper.

Q. I mean the gross sewage volume.

A. The total quantity of sewage from the Metropolitan District, including Boston, is at about the present time 216,000,000 gallons daily.

Q. That is from the entire Metropolitan Sewerage District of Boston?

A. Yes.

Q. What is the entire approximate amount of sewage and trade waste discharged from the City of New York?

A. Roughly, it is about 120 gallons per person, it may be more in some places, but on that basis 6,000,000 people would make a total of 720,000,000 gallons daily.

Q. How many manufacturing plants are discharging their trade waste through the Metropolitan sewerage system of Boston?

A. All that exist within the Metropolitan District practically.

Q. Can you give me an approximate idea of their number?

291 A. No, I could not.

Q. Can you give me an approximate idea of the number of manufacturing plants that discharge their trade wastes from the City of New York?

A. I cannot.

Q. Can you give me any rough idea at all as to the number of thousands?

A. Not as to numbers at all. I could tell you some of the particular manufacturing establishments that discharge into the sewers, but it would be a very small proportion of the whole.

Q. Would it surprise you to know that there are 43,000 manufacturing plants in the Greater City of New York that discharge their trade waste into the surrounding waters?

A. I have never looked into such statistics, so I wouldn't be surprised with any figures.

Q. In your answers to Mr. Riker's questions, when you used the term "sewage" did you include trade waste?

A. Yes, everything that goes through the sewers.

Q. You used "Sewage" in its generic sense?

A. I used it as to the matter that is discharged through sewers.

Q. How many manufacturing plants will contribute trade waste into the Passaic Valley trunk sewer?

A. I have not looked into that matter at all.

292 Q. Have you looked into the character of the trade waste that will be contributed by these plants?

A. No.

Q. Are you familiar with the trade waste from wool manufacturing plants?

A. I have had something to do with the waste from wool washing.

Q. It is particularly objectionable and difficult to treat, is it not?

A. It is in the way that I have had occasion to treat it, that is, by filtration; the grease and hair wool is troublesome for that kind of treatment.

Q. Do you regard the Upper Bay of New York as in any way resembling the Harbor of Boston?

A. I think it sort of resembles it to some extent.

Q. Will you state what points of resemblance they have in common.

A. Tide water that runs into and out of them; that is the principal point of resemblance.

Q. Now, as to the tidal ranges of the two bodies of water, what do you say about that?

A. The tidal range in New York waters, except for Long Island Sound, is about half that in Boston.

Q. What is the tidal range in Boston?

A. 9.3 feet on the latest examination I have seen.

293 Q. Running up to what: how high does the tidal range go?

A. For any ordinary spring tide I think that there is a difference of about two feet in excess of the ordinary high tide.

Q. In Boston?

A. Yes. Of course wherever there is a tremendously easterly storm, it goes still higher.

Q. Boston Harbor is an open arm of the sea, is it not?

A. I should hardly call it so; there are only two—it is fairly well enclosed by islands, Moon Island, Nut Island, Deer Island, and there are only two outlets of any material size.

Q. What do you know of the currents as to their velocity and direction in Boston Harbor?

A. I made current measurements before the Moon Island sewer was in operation and know about what they were there, although I have to give it from memory, and I know that the currents are stronger both at Nut Island and Deer Island than they are in the vicinity of Moon Island.

Q. What are the velocities of those currents, approximately?

A. At Moon Island, at the time of the discharge of the sewage, I think the velocity is about three quarters of a foot per second, and as the sewage moves down stream it gets into stronger cur-
294 rents. At Deer Island I think the velocity gets as high as three feet a second, possibly higher at the strength of the tide, that is, out in the channels.

Q. And what is the velocity of the ebb current in the Upper Bay of New York?

A. I don't know that of my own knowledge and it would only be an attempt to give a statement from memory of what is contained in the reports. It is a good fair current and it is likely to increase at times of high water in the Hudson.

Q. What is the tidal range in the Upper Bay of New York?

A. I do not remember precisely, but somewhere in the neighborhood of four and one-half feet.

Q. Then you cannot give me the velocity of either the ebb or flood currents in the Upper Bay of New York?

A. Only by turning to a report and reading from that.

Q. Aren't those rather important matters in making estimates of possible dispersions or diffusions of sewage?

A. Yes.

Q. Are there any vertical currents in the Upper Bay of New York?

A. Yes.

Q. Where?

A. Practically everywhere as the water flows with consider-
295 able velocity, it always produces vertical currents as well as horizontal.

Q. Are you making that as a general statement or as a special statement with regard to the Upper Bay of New York?

A. I am making it both as a general and as a special statement.

Q. On what do you base that statement in relation to the Upper Bay of New York?

A. Largely upon my studies. For instance, I wrote a paper at one time on the reason why the maximum velocity of water is below the surface, which led me to study the question of vertical currents, and one of those studies included experiments by Mr. James B. Francis

of Lowell, who turned lime water or milk of lime through a pipe into the bottom of the canal, and it came to the surface within about—some very short distance I don't recall, it was inside of 100 feet from a depth of fifteen or sixteen. That it has been my general experience, in studying these questions, that overturning occurs frequently as the result of current, but in New York Upper Bay it would be retarded somewhat by the difference in the density of the water at the surface and at the bottom. That difference in density is not sufficient to prevent a very considerable mixing, as is
296 shown by the fact that there is a good percentage of land water down at the bottom.

Q. Have you ever seen any data that showed land water in the Upper Bay of New York?

A. Yes.

Q. Where?

A. Reports of the Metropolitan Sewerage Commission, from a great many determinations.

Q. Showing land water at the bottom?

A. Showing the percentage of land water at the bottom?

Q. In the overturning that you just alluded to of the water strata, doesn't that relate more particularly to fresh water bodies?

A. Entirely fresh water bodies will turn more quickly more frequently with the currents—with the same currents, than if they are partly salt and partly fresh, because of the greater salinity of the water at the surface. During a portion of the year there is no noticeable difference from the top to the bottom in New York Harbor.

Q. And the experiments that you just described with milk of lime, was that a question of specific gravity with vertical upward movement?

A. Not at all.

Q. What was it due to?

A. Due to the currents that are always taking place in run-
297 ning water by which mixing occurs.

Q. And if that had been put into an inland lake, what would you expect?

A. The milk of lime would have stayed at the bottom because that would be heavier than the water, and there would be no currents to force it up.

Q. Do you understand that vertical currents invariably move upward?

A. Of course they move downward as well as upward.

Q. Are there any downward currents in the Upper Bay of New York?

A. Yes.

Q. How do you know that?

A. Matter of general knowledge, that where there are currents there are sure to be vertical currents both up and down.

Q. You have never studied any experimental determinations to settle that feature?

A. I have, many of them.

Q. With regard to the Upper Bay of New York?

A. No.

Q. What is the present population that contributes sewage to New York Upper Bay?

A. In round numbers it is about 5,800,000 exclusive of the population contributing to New York Bay from the Passaic Valley District and from the westerly side of some of the New Jersey
298 cities.

Q. How does the Passaic Valley District contribute sewage to the Upper Bay of New York?

A. Because that is the natural outlet for the greater part of the discharge of the Passaic River, hence the resultant flow is in the New York Upper Bay.

Q. Will sewage travel from the Passaic River into the Upper Bay of New York?

A. I don't think it does as sewage.

Q. Do you regard the Passaic River as an elongated septic tank at present?

A. I should think that might be the case, but I have no definite knowledge except an occasional glance at the River as I go by; I have heard that statement.

Q. By whom?

A. I don't know.

Q. Have you read any of the testimony in this case?

A. Very little.

Q. Regarding the Passaic River as elongated septic tank, there would be a decanted effluent reaching Newark Bay, would there not?

A. I don't know that it would be decanted; the flow of the river must get down there, and it would be carried back and forth with the tidal currents of the river, with the result that it forces the supernatant liquid from the sludge deposits into Newark Bay.
299 Q. How do you account for the fact that the oxygen content is higher in Newark Bay than in the Passaic River, if the sewage from the Passaic River is commingled with the Bay?

A. The question of reaeration.

Q. Newark Bay has many physical advantages for reaeration, has it not?

A. I don't know that it has over other places, but it has sufficient advantages for reaeration to take care of the present sewage that comes into it, but I am fixing my date back to 1909 and 1911, because I have no more recent data.

Q. Do you recall what the oxygen content percentages showed for the lower parts of Newark Bay?

A. The average of many observations was seventy.

Q. Do you know what the oxygen determinations for Robbins Reef and that region were?

A. No, I did not make the comparison for that particular time.

Q. Seventy is a very good high oxygen content for Newark Bay, is it not?

A. Yes.

Q. And from the standpoint of New York, the sewage digestion

taking place now in the Passaic River is eminently—satis-
300 factory, is it not?

Mr. Riker: The question is objected to on the ground that it is not cross-examination and is immaterial and irrelevant.

Commissioner Maher: The objection will be noted.

A. I think it should be.

Q. I understood you to say that you were engaged at some time in prescribing a sewage disposal system for Baltimore?

A. Yes.

Q. What system did you recommend there, Mr. Stearns?

A. First, coarse screening of the sewage, after its collection, and bringing it to certain points; then the discharge of the sewage into flat-bottomed settling tanks, from which the sludge would be removed into digesting tanks; then the discharge of the effluent from the settling tanks through sprinkling filters, with broken-stone filters about nine feet in depth; then the discharge of the effluent from these sprinkling filters into settling basins, and then the further purification of that sewage through artificially constructed sand filters.

Q. That gave you a very satisfactory effluent, did it not?

A. The sand filters were never built. The other works gave a satisfactory effluent, and the only reason that the engineers
301 making that plan included the sand filters was, that the act of the legislature said that no sewage should be discharged into the waters of Chesapeake Bay, and the decision of the Commission as to what it meant, that no sewage should be discharged into Chesapeake Bay, was that it must be purified to the greatest extent that could be done by any means.

Q. You used the term, "Digesting tanks"; what do you mean by that method of treatment?

A. When sewage is carried through flat-bottomed tanks a deposit occurs on the bottom, and under the system in vogue at that time, it was known that if that sludge remained for a long time on the bottom of those flat bottomed tanks, it would give off gases and cause a good deal of trouble with the sedimentation process, hence arrangements were made to clean the tanks rather frequently and discharge the sludge and some of the sewage into these digesting tanks, where the sludge could remain and acquire a septic condition, and it was then thought that that would diminish the amount of sludge to be subsequently taken care of, and also make it in a better form after it had been thoroughly digested for disposal.

Q. Did those digesting tanks which you have just described, Mr. Stearns, accomplish work somewhat similar to the Imhoff
302 tanks?

A. I think it might be said to be somewhat similar, but yet different in this respect that with these flat bottomed tanks, as matters were arranged, they could not discharge the sewage into these digesting tanks very frequently; whereas, in the Imhoff tank there is a continual accretion of fresh sludge on top of the old sludge.

Q. The Imhoff tank is the latest and most improved device for the bacterial treatment of sewage and sewage sludge, is it not?

Mr. Riker: The question is objected to on the ground that it is not cross-examination, and immaterial and irrelevant.

Commissioner Maher: The objection will be noted.

A. I am not posted as to the latest thing in Imhoff tanks, but one was put in at Baltimore subsequently and it did not work successfully and its use was given up.

Q. But the principle of this digesting tank is the same as that used in the old septic tank and in the Imhoff system?

A. Somewhat the same as I have described.

Q. It is a bacterial disintegration of the organic matter, is it not?

A. That was what was intended.

303 Q. Will you describe the sprinkling filters. I understand that from the digesting tanks, the effluent was then treated in sprinkling filters?

A. From the settling tanks, not from the digesting tanks.

Q. Oh, the settling tanks.

A. These sprinkling filters were made by laying first a foundation consisting of many drains, and also there were concrete walls separating the different sections of the sprinkling filters. On the floor proper with all these drains was placed broken stone from one to two and one-half inches in diameter, until a depth of nine feet was attained. Then pipes were laid from the main sewer, main effluent carrier, all over these beds in parallel lines, and on the tops of those pipes there were placed these nozzles through which the sewage would be discharged in a spray, so as to cover by the drops, as nearly as possible, the whole area of the broken stone.

Q. And the object of that was to bring the sewage effluent in contact with the oxygen of the air, was it not?

A. Yes.

Q. And oxidize it thoroughly?

A. Both bring it in contact with the air as it went in drops through the air, and also in contact with the air as it trickled in thin films from these stones.

304 Q. So that it would be pretty thoroughly oxidized; that was the object.

A. That was the object, to very thoroughly oxidize it.

Q. In the sedimentation basins what detention period did you use in Baltimore?

A. I don't recall.

Q. About?

A. It was as much as four hours.

Q. And that period you considered would be adequate to get a very large share of sedimentable matter deposited?

A. It was thought so at the time.

Q. Was there any discussion as to a shorter period of detention at that time?

A. I do not recall.

Q. But whether there was or not, that period of four hours was considered requisite for a detention period?

A. I might say that that was more nearly the practice at that time, because it was before tanks had been built in which the gases would be prevented from coming up through the settling basins, like the Imhoff tank, and one had to count at that time to a large extent upon the effect of those bubbles of gas coming directly up through the sewage. In that the matter changed to a large extent, and that is to be changed here in the Passaic plan, by putting in these
305 hopper bottoms, so arranged that the sludge can be taken out of the bottom periodically, and thus prevented from accumulating and furnishing those bubbles of gas.

Q. What is the detention period prescribed for the Passaic Valley sedimentation basins?

A. It is required by the stipulation,—which is my only guide at present, because the plans are not available,—that the tank capacity shall provide for a detention period of not less than one hour at the maximum rate of flow of sewage, and not less than an hour and a half at the daily average rate of flow.

Q. You were present when Mr. Fuller testified, were you not?

A. Yes.

Q. How would lowering the velocity without increasing the detention period aid in sedimentation?

A. I cannot answer that question; I haven't looked into any of those matters of sedimentation for years—many years, and am not up with the latest proceedings in those things.

Q. What is the population of Baltimore?

A. Approximately,—I don't know at all nearly—I think it is 600,000, or more.

Q. And what did you estimate the population that would contribute to the Passaic Valley trunk sewer at?

Mr. Riker: The question is objected to on the ground that
306 this witness hasn't said that he has estimated the population, and there is nothing in the record that shows that he has made any such estimate.

Commissioner Maher: The objection will be noted.

A. I have made no such estimate.

Q. In determining such an important factor as the treatment of sewage, is it not necessary, Mr. Stearns, to estimate the number of people that will contribute that sewage?

A. It is desirable to know approximately how many, and I have seen various reports and estimates, but have made no estimate myself, running all the way from 850,000 up to 900,000, that is in the whole district.

Q. Are there many manufacturing plants contributing to the sewers in Baltimore?

A. I presume there are, but I never looked into it carefully, so I cannot give you any information on that point.

Q. But whatever the character of the sewage and trade waste of Baltimore, this system that you have described as having prescribed

for Baltimore, has successfully coped with the difficulties and the problems of the sewage disposal adequately?

A. It has, so far as I know, but I haven't examined the
307 works since they were entirely completed. I saw them when they were first put into operation and the sewage coming was largely water.

Q. Did you recommend the Baltimore system or the system that you prescribed for Baltimore's use, to the Passaic Valley Sewerage Commissioners, or their counsel, or any representative of the Commission?

A. No.

Recess.

Q. Mr. Stearns, you were given free access by the representatives of the Board of Estimate and Apportionment of the City of New York to their oxygen determinations and to such data as you wished to consult, were you not, in relation to the sewage disposals?

A. No; I visited the engineer of Sewage Disposal, and asked him for such things as were published that I knew he would have authority to give, which he kindly gave me, but I did not ask him with regard to anything else, because I was not authorized at that time.

Q. Did he withhold anything from you that you asked for?

A. No, because I said I thought it was not proper for me to ask for anything except what was published, and he said he would procure the consent of counsel before giving anything else.

308 Q. And you finally did get what you asked for, did you?

A. Yes. I only asked for published reports that were evidently public.

Q. You didn't examine the oxygen determinations?

A. No.

Q. That was Mr. Kenneth Allen, the sanitary engineer that you spoke with?

A. Yes.

Q. He is Sanitary Engineer of the Board of Estimate and Apportionment of the City of New York?

A. Yes.

Q. You visited the Dyckman Street plant, you said?

A. I did.

Q. And you found the screens as you described in your direct testimony?

A. Yes.

Q. As to that ispection trip, as I gathered it, you travelled around the island of Manhattan in a gasolene motor boat?

A. Yes.

Q. In studying the condition that you found in the Hudson River, you ascribed its turbidity to "the natural flow" rather — to sewage pollution?

A. Yes.

Q. Will you please explain what you mean by "the natural
309 flow" that causes turbidity?

A. The Hudson River water at times has in it turbidity

due to the effect of rainfall and scouring of clay beds and so forth.

Q. There were very heavy rains during the weeks preceding your tour of inspection, were there not, in this watershed of the Hudson River?

A. I do not recall distinctly, but I think there were.

Q. Do you know of any clay formations along the Hudson River watershed?

A. Not specifically, except in the Catskill drainage area, I knew of some which caused turbidity at times.

Q. From a boat looking into the water how would you determine whether the turbidity was due to admixture of clay or other natural geological formation, from a similar condition of turbidity that might be induced by sewage?

A. I think it would be difficult to determine by a mere inspection what the cause was. I was guided by the fact that the Hudson River is itself turbid at times.

Q. From what causes?

A. From natural causes, such as rainfall and flow of water from the upland.

Q. Now, you found a condition of turbidity during that same trip, I think it was, you said, on the second of May?

310 A. Yes.

Q. In the Harlem River?

A. Yes.

Q. And you ascribe the turbidity there to the turbidity that came into the Harlem River from natural causes and from the Hudson River?

A. For the northwesterly portion of the Harlem River, I think that was the case. It was not so clear that that was the case toward the southeasterly portion; it seemed more likely that was due to sewage.

Q. Was there very much difference between the two parts of the Harlem River where the turbidity was due to clay or other admixture or natural causes, and the turbidity that you found was due to sewage pollution?

A. Not very much, no; I cannot distinguish definitely between the two.

Q. But at the time that you inspected the Harlem River, you knew that it was a very heavily polluted river, did you not?

A. No, not at the time of my visit I didn't know it; I know that it is heavily polluted at some times of the year.

Q. I understood in your direct testimony that you stated that the oxygen content was found on one occasion there at zero?

311 A. That was in the hot weather.

Q. Isn't sewage disposal and sewage nuisances and sewage problms chiefly a summer question?

A. Yes, in most places.

Q. Why?

A. Because under ordinary circumstances the water contains less oxygen in summer to digest the sewage, and decomposition is more rapid in summer than it is in cold weather.

Q. And when the water is below forty degrees, bacterial life is not very active, is it?

A. I think it is not.

Q. Most low forms of life hibernate at a low temperature, do they not?

A. That isn't the case with some forms.

Q. Taking sewage bacteria, are they active or inactive during low water temperatures?

A. I think they are inactive.

Q. You have less volume of fresh diluting water in the Hudson River and in the Upper Bay of New York during the warm season, do you not?

A. Yes, as a rule.

Q. And the warmer the weather is, the less oxygen it is able to hold?

A. Yes.

312 Q. Do you recall whether salt water or fresh water can hold in solution the larger percentage of oxygen?

A. Fresh water can hold the larger percentage.

Q. And how about brackish water as compared with ocean water and with fresh land water, as to the percentages of oxygen contained in it?

A. The brackish water can hold more than the extremely salt water and less than the fresh water.

Q. How much less than the fresh water?

A. I don't have those figures directly in mind.

Q. Approximately?

A. I would refer to a table for that.

Q. Can you give me an approximation in percentages?

A. Not what would be the average, I think; if I had to estimate, it would be in the neighborhood of twenty per cent, but I may be——

Q. Less?

A. Less in the salt than in the fresh.

Q. It is generally placed, I think, Mr. Stearns, at about fifteen per cent?

A. Well, I do not know within those limits; it is a matter I have had to do with but little, and I refer to a table when I wish to know.

Q. As to the condition of the East River, I understood you to say that the water there you found clearer and with some oily

313 sleek, but not very much?

A. Not much oily sleek, but there was less turbidity; it was more ocean water at the time we passed into it.

Q. How as to its condition of pollution?

A. I would judge there was no indication of pollution that could be seen during the visit, except some of these features, like occasionally some oily sleek or the pollution near a sewer outlet; that is, there was no obvious pollution at that time in the water as a whole.

Q. I will ask you to define what you mean by "Obvious pollution?"

A. Obvious pollution is pollution that can be observed by the eye,

either in the discoloration of the water, due to sewage or any offensive matters that naturally would come from sewers.

Q. May water be heavily polluted and yet look clear?

A. Not generally.

Q. And as far as you could determine, the East River was not seriously polluted, is that it?

A. Not at the time of the visit; I am speaking now of the portions out in the current.

Q. About how far from the land lines were you, about half way between the two shores?

A. As we passed Blackwell's Island, we were quite near
314 the New York Shore, but after that—I do not recall very definitely, but I think we were pretty well out into the stream, rather on the New York side; my recollection is not clear on that point.

Q. Did you look up any oxygen determinations or bacterial investigations as to the condition of the East River?

A. Yes, I did.

Q. And what did they disclose to you?

A. They disclosed that the oxygen content, in the lower East River especially, is as a rule lower than in any other large arm of the waters surrounding New York, except the Harlem, and that the summer oxygen content was at a low point.

Q. And how about the lower reaches of the Hudson did you investigate the oxygen content as disclosed by direct investigations and determinations?

A. Yes.

Q. And how did you find that, Mr. Stearns?

A. As a rule there is a good supply of oxygen at that place, but under the extreme conditions it is lower; I do not recall now just how low.

Q. At Robbins Reef you noticed most of the oily sleek, I understood you to say?

A. Yes, there was a larger field of oily sleek between Robbins Reef and Constable Point, not directly at Robbins Reef, than
315 there was in any other place that we visited on that trip.

Q. And Robbins Reef is the site selected for this trunk outfall sewer?

A. Yes.

Q. On the Brooklyn side you stated that the sewage pollution there was most noticeable; how was that most noticeable?

A. It seemed to have a different color and be more turbid in that part of the Upper Harbor than any other places that we visited; it was not a positive determination, but that was the judgment both of myself and of others who were on the boat.

Q. The discoloration was what made you make those inferences there?

A. Yes, the discoloration appeared to be rather different from that in other parts of the Harbor, not quite the same brownish color as the turbidity of the Hudson.

Q. Can't you describe the color?

A. No, not at all definitely; it was a little more on the drab, perhaps, than on the brown. I don't think that would be a very definite description; I merely remarked that it was somewhat different.

Q. In describing the sewage discharges from Manhattan Island, you said that the sewage was untreated and discharged at
316 the piers and slips, and that it left sludge deposits. How would you remove that condition from Manhattan Island?

A. By extending the outlets into deep water, the Piers and by providing screens in all places where it is practicable.

Q. Where would you install screens on Manhattan Island?

A. It would be, if possible, in land outside of the streets; I think they could also be installed underneath the streets; I have not given any detailed study to that work. The different reports that I read indicated that this might be done.

Q. In your tour of the Harbor, Mr. Stearns, did you examine the mode of discharge and the line of sewage disposal treatments adopted on the Jersey side of the Hudson River?

A. Only incidentally as we passed in on our way up the Hudson River pretty well toward the New Jersey side, where in one case we saw a sewer discharging—I cannot locate it now, and above that we saw some of the oily matters.

Q. Do you know what the sewage discharges, as to volume, amount to from either Hoboken, Jersey City, Weehawken or Bayonne?

A. Only as I could infer that from the number of people,
317 and the number of people I believe about 400,000 at the present time, not including Weehawken, which I didn't include, but that might also be included in that figure, I believe, it is not a large place—and assuming 100 gallons per person, it would amount to 40,000,000 gallons per day. That will give a rough idea of the amount.

Q. In estimating a sewage per capita, such as you have just done, what basis do you take for that calculation?

A. Approximately the water supply, and in a district where there was much low land, I would add a considerable amount for ground water.

Q. In the manufacturing districts is that a very safe or accurate mode of computing the sewage per capita?

A. That depends on whether the manufacturers have to depend upon the water supply or not; when there is only a salt water supply available, as a rule they have to use—they take water only from the public water supply and hence it is an accurate method. In the case of manufacturers along fresh water streams, there might be a large quantity of water taken from these fresh water streams directly by the manufacturers, which goes into the sewers, and that would add to the public water supply.

Q. Taking a city like Paterson, can you give me some idea
318 of how many gallons of water would be consumed in the manufacture of a pound of silk, say?

A. I have never made any estimates of that kind.

Q. Didn't you estimate trade waste under the heading of sewage?
A. That depends upon circumstances.
Q. If I ask you what the sewage of a city like Paterson was per capita, wouldn't you estimate the trade waste in making the calculation?

Mr. Riker: The question is objected to on the ground that it is not cross-examination, immaterial and irrelevant.
Commissioner Maher: The objection will be noted.

A. I should study the question of trade wastes and include such portion as I thought ought to go into the sewers.
Q. Did I understand earlier in your testimony, Mr. Stearns, that under the term sewage you included everything that went into a sewer and was transported in the sewers?
A. Yes.
Q. So that if trade wastes were discharged into the sewer you would calculate them as sewage?
A. Yes, that portion of the trade wastes that were taken in the sewers, I should assume to be sewage.
Q. Taking Hoboken or Jersey City, do you know of any
319 other disposal of their trade wastes than through the sewers?
A. I do not know anything about the disposal of trade wastes in those cities.
Q. In discussing the conditions in the Gowanus Canal I understood you to say that $950,000 was spent by the City of New York in flushing out that canal?
A. That wasn't the precise statement; that according to an official report $950,000 was spent for works for flushing out the canal. And in addition to that, there would be the cost of maintaining and operating that plant, if it were maintained and operated.
Q. So I understated the amount of money that New York City spent in flushing the canal?
A. I think so, if those works were operated.
Q. Do you know whether they are or not?
A. Only by hearsay.
Q. And the object of those works in flushing that canal was what?
A. To force—to take water from the upper end of the canal and force it into Buttermilk Channel, thereby drawing in from the Upper Bay cleaner water to replace the putrid water in the canal.
Q. In other words, that would remove the polluted matter right out into the main stream of the East River?
320 A. Into Buttermilk channel, which is an extension of the river?
Q. Yes, and that is the remedy you now suggest for the Island of Manhattan to carry its sewage out into the main channel of the river?
A. Yes, that is one remedy; I beg your pardon, not into the main channel of the river, but into the easterly portion of the Upper Bay, south of Governor's Island.

Q. You mean from the Hudson side of the Manhattan Island?
A. No, from the Brooklyn side.
Q. I am now asking you, Mr. Stearns, if you haven't suggested a method for relieving the Hudson side of Manhattan Island of sewage pollution by just the methods that they have already adopted in the Gowanus Canal?
A. I evidently misunderstood the previous question, and probably answered it wrong on that account. No. In regard to the Hudson River side of the Manhattan Island, the method is not the same as in the case of Gowanus Canal.
Q. Isn't the object to remove the polluting matter into the main current of the body of water known as the Hudson River?
A. It is to discharge it into the main current of the Hudson River.

321 Q. Whether you discharge it through a pipe or whether you flush it out by a body of water, isn't the objective the same, to have it reach the central current of the body of water?
A. The cases are not similar.
Q. The methods may be different, but how does the objective differ?
A. The objective in the case of the Gowanus Canal was to take a body of water already polluted and force it into a body of water that was less polluted. In the case of extension of sewers into the Hudson River, it will be the purpose, not to deposit the sewage to be subsequently pumped again and forced out into the channel, but to take it and deposit it in the first instance directly into the currents of the Hudson River.
Q. So that the polluting matter in each case would reach the less polluted body of water in the central current of the bodies into which it would be discharged?

Mr. Riker: The question is objected to on the ground that it is a conclusion of counsel and not based upon the testimony of the witness, the testimony of the witness being that he would take the sewage itself from Manhattan Island and discharge it into the refreshing and not polluted water of the Hudson River.
Commissioner Maher: The objection will be noted.

322 Q. Did you examine Newtown Creek?
A. No.
Q. Have you at any time examined Newtown Creek?
A. I have not.
Q. Do you know anything of its manufacturing plants or of its commerce?
A. No.
Q. How would Newtown Creek compare with the Mississippi River as to the body of its commerce?

Mr. Riker: The question is objected to as not cross-examination, and as being immaterial and irrelevant.
Commissioner Maher: The objection will be noted.

A. I have already stated that I didn't know the commerce of Newtown Creek, hence I cannot make a comparison.

Q. Do you know whether or not the commerce and the tonnage accommodated on Newtown Creek exceeds the commerce of the Mississippi River?

Mr. Riker: Same objection.

Commissioner Maher: The objection will be noted.

A. I do not.

Q. Would it surprise you to know that what is very little more than an open sewer in one of the arms of our Harbor waters, should exceed in value, in its tonnage and commerce, the great River of the Mississippi?

Mr. Riker: The same objection, and the further objection that whether the witness is surprised or not doesn't seem to be material to the case.

Commissioner Maher: The objection will be noted.

A. I have no ground for surprise.

Q. Have you any views either way, Mr. Stearns?

A. No.

Q. In your examination of the Harlem River, when you stated it was more than a local nuisance, what did you intend to imply?

A. I meant it was a condition of affairs that could not be treated by rearrangement of the outlets locally but that it would be necessary to actually divert from the stream a part of the sewage which now enters it, or the whole of it.

Q. Did Mr. Kenneth Allen, the Sanitary Engineer of the Board of Estimate and Apportionment show you plans that were already perfected by the engineering department of the Board of Estimate and Apportionment, for that very relief?

A. No.

Q. Do you know whether or not such plans have been prepared?

A. I do not. The only plan that I am acquainted with was contained in the report which he gave me of the New York sewer plan commission, and I did not ask him with regard to anything that was not published.

Q. While you found the East River in its physical appearance clearer and in better condition, as far as any observable indications of pollution were concerned, why did you suggest that it needs immediate relief?

A. I did not mean to say that it was clear and entirely free from pollution, but that it was clearer than the Hudson. The reason for that, that it needs prompt relief—not necessarily immediate relief,—is—that the oxygen content there in this entire portion of the Harbor well away from the refreshing influences of the salt water and receiving a great deal of sewage, that the oxygen content has always been lower than any other parts of the—than most other parts of the Harbor—and was found to be very low on some recent occasions, according to the report of Mr. Allen of 1917.

Q. In relation to the lower reaches of the river and the refreshment which you say will come from the ocean water, what percentage of that ocean water is pure ocean water that reaches
325 the lower reaches of the East River?

A. None of it as it reaches it is pure ocean water.

Q. What percentage of it would be capable of refreshing in any degree the lower reaches of the east river?

A. I think practically all of the water that goes toward the lower portion of the East River would be capable of refreshing it. Some of it, that is to say the water outside the limits of the East River, is better than the water within the limits of the East River, and consequently it tends toward refreshment. It may not be sufficient to overcome the action of the sewage, in view of the large quantity of discharge there.

Q. Were you present when I asked Mr. Fuller what percentage of the flow entering the Upper Bay of New York was water that had already receded from the Upper Bay on the ebb and was now returning on the flood?

A. Yes.

Q. And what percentage was that that returned?

Mr. Riker: The question is objected to on the ground that it is too indefinite to tell what it is directed at. The preceding question was whether he was present.

Commissioner Maher: The objection will be noted.

A. I don't remember what he said.

Mr. O'Sullivan: I will put a question elaborate enough
326 to suit your objection, Mr. Riker.

Q. Of all the water that returns to the Upper Bay on each flood tide, what percentage of that water has already been in the Harbor, been polluted and left the Harbor on the preceding ebb tides?

Mr. Riker: If the witness knows.

A. I cannot answer that question definitely.

Q. Were you present when I read to Mr. Fuller, the estimate made by General Robert who had been president of the Harbor Line Board from 1895 to 1902, I think it was, and who gave the estimate that ninety per cent of all the water that comes in on the flood into the Upper Bay of New York had already been in the Harbor, been polluted and left the Harbor on a preceding ebb tide?

A. Yes.

Q. Have you any reason to doubt his estimate?

A. Yes.

Q. What are your reasons?

A. I think the estimate is low; I think the estimate of the quantity of new water coming into the Harbor on a tide is low, that is, that more comes in than the ten per cent.

Q. About how much more would you say, Mr. Stearns?

A. I haven't a definite figure on that, but I should think it would

be more nearly twenty or twenty-five per cent, or perhaps more
327 than twenty-five per cent.

Q. Do you base that opinion on any data that you have consulted or is it based on any salinometer or other work that you yourself have conducted in New York Harbor waters?

A. It is based largely upon studies that have been made by others. It seemed to be reasonable, as a general rule, and I am referring more particularly to the studies of Mr. H. De B. Parsons and Mr. Hazen. I did not conclude my own studies on the subject so as to have a thoroughly definite opinion.

Q. How would you determine that fact as to how much percentage of the incoming flood waters were fresh sea-waters?

A. It would be partly a matter of judgment, and partly a matter of following along the lines of Mr. Parsons' computation based on salinometer measurements, and still further it would be based in part upon a study of the currents.

Q. What is the velocity of the currents in the Upper Bay of New York?

A. They are very variable in different places, and I do not have the figures except as I would read them out of some book, but I should say that at the strength of the currents, they were three feet a second in many places,—in places, from two to three feet a
328 second.

Q. In determining the digestive capacity of a body of water and in determining what the safe margin of pollution would be, what factors would you take into consideration?

A. As important factors, there is the amount of fresh water and of salt water containing dissolved oxygen that comes in the various inlets and outlets, owing to the tidal currents, and the fresh water would be the flow of the Hudson River. Then there is the element of reäeration. Those are the principal elements.

Q. Does a shallow body of water or a deep body of water reäerate the waters in that area more rapidly or less rapidly?

A. That depends upon circumstances. In times of quiescent weather the shallow body of water would reäerate more rapidly.

Q. What would you take as the standard of measurement if you were now requested to design a sewage disposal system for a community, and there was an adjacent body of water that you expected to discharge either the sewage or the effluent from a sewage disposal works into, and you were to determine whether the capacity for digestion existed in the recipient body of water?

A. The volume of water and its oxygen content would be important factors, and various studies might be made. For
329 instance, in the case of discharging sewage into a stream, as in the case of the Chicago drainage canal, there is experience showing how many cubic feet per second per thousand of population is necessary. In that connection it would be necessary also to consider the manufacturing wastes.

Q. Would you take into consideration, Mr. Stearns, the sludge deposits beneath the body of water that you were about to discharge either the sewage or the sewage effluent into?

A. That might be an important factor in some cases.

Q. As a general rule, do you attach importance to it?

A. Sludge deposits are certainly important.

Q. Do sludge at the bottom of a body of water receiving sewage or sewage effluent consume more oxygen from the supernatant water than does the fresh sewage or sewage effluent discharged into that body of water?

Mr. Riker: The question is objected to on the ground that there does not appear to be any basis for the witness to answer; it is too indefinite.

Commissioner Maher: The objection will be noted.

A. The answer would depend upon the conditions. If sewage were discharged from the deposits in Black Creek from the
330 Chicago stock yards, the sludge deposits in the bottom of the creek would have a great deal more influence upon the dissolved oxygen, in my judgment, than would a moderate amount of sewage. On the other hand, there might be very limited sludge deposits, and the sewage would be the controlling factor.

Q. Have you any knowledge as to the measure of sewage deposits at the bottom of the Upper Bay of New York, Mr. Stearns?

A. Only very indefinitely, by inference from other places, if you refer to the Upper Bay proper.

Q. Yes, I refer to the Upper Bay proper, above the Narrows.

A. In the portions of the Upper Bay, where there are good currents, I should not expect that there would be any material sludge deposits from the discharge of sewage. I am speaking now of the Upper Bay, where there are currents and not at all of the sheltered portions in the slips, between piers and other places which are sheltered.

Q. Do the saline matters in the incoming waters on the flood into the Upper Bay act as a precipitant on the sewage matters or the sewage effluents that have been discharged into the Upper Bay?

A. I do not think there is any material action of that kind, for the reason that from day to day saline contents of the Upper
331 Bay do not change much.

Q. The salt water does not act as a precipitant on sewage material either comminuted or suspended in the waters into which they are discharged.

A. That was not covered by the other question, that is, it is not applicable to this particular case. If you are speaking of pure saline waters, I do not know.

Q. What would you regard as the safe measure or margin of oxygen to be retained for the Upper Bay of New York?

A. It is difficult to answer a question that is so broad and covers so many different locations. In any given location within the Upper Bay I think the oxygen content could go down to twenty to thirty per cent of saturation, without causing any offense.

Q. Did you find in your tour of inspection any offensive conditions from the sewage discharges?

A. No.

Q. Do you know of anywhere in New York waters, outside of the Harlem River, where the oxygen content is down to twenty per cent?

A. (After examining pamphlet.) No, not as a rule.

Q. Are you familiar with the oxygen determinations in the Passaic River and Newark Bay?

A. I have examined those in Newark Bay very carefully, and have noted some of them in the Passaic River.

332 Q. What is the highest oxygen content determinations that you know of for the Passaic River within the last six years?

Mr. Riker: The question is objected to as being too general.

Commissioner Maher: The objection will be noted.

A. I do not know of any examinations made within the last six years.

Q. Within the last ten years, do you know of any?

A. I have seen the record of some within the last ten years.

Q. Were you present when I read the oxygen determinations made by Professor Earl B. Phelps, in which he found thirty-eight per cent of oxygen saturation in the Passaic River in the region of Newark?

A. Yes.

Q. And was there a nuisance at that time in the Passaic River?

A. I do not know.

Q. Do you recall that part of his testimony in which I directed Mr. Fuller's attention to the fact that the conditions there were such that they didn't need comment they were so bad?

A. I heard that statement in the question to Mr. Fuller.

Q. And according to your testimony now, if the oxygen
333 content was from twenty to thirty per cent, there would be no nuisance?

Mr. Riker: The question is objected to on the ground that that is not this witness' testimony. There are other conditions which must be present, in order to have that statement apply.

Commissioner Maher: The objection will be noted.

A. That is not correct as applied to conditions with sludge deposits underneath the water.

Q. As you have already testified that you do not know what the extent of the sludge deposits in the Upper Bay of New York is, how then can you determine what a margin of safety would be as to the percentage of oxygen saturation for the Upper Bay of New York?

A. I have already stated that I could judge from my general experience that there would not be putrid sludge deposits in New York Upper Bay where there are good currents because I know that they are not present under similar circumstances near the outlets from the Boston main drainage systems; that is, near those outlets they have been unable to find any sludge deposits, as the currents carried the sludge away; and the conditions are not at all comparable in those bodies of water with currents, with what they be in the
334 lower part of the Passaic River, or in a place like the Gowanus Canal or in the slips between the piers.

Q. Do you know of any peculiar conformation of the bed of Upper New York Bay that would prevent sludge deposits being carried through the Narrows into the Lower Bay?

A. No.

Q. In dredging for the Ambrose Channel, had you occasion at any time to look at the dredged material that was being taken up by the Federal Government dredges?

A. No.

Q. And have you any knowledge on the subject as to its character, whether putrid or otherwise?

A. No.

Q. And as to the fact whether or not they had to discontinue dredging during warm weather on account of the putrescent gases that were evolved from the filthy material that they dredged up?

A. I am not informed.

Q. What is the population of the Bronx, Mr. Stearns?

A. Approximately 700,000.

Q. What is the population of Queens?

A. I should say 450,000 to 500,000.

Q. And would that long intercepting sewer relieve both those conditions by removing the organic filth which is being dis-
335 charged through the sewers, and taking it to Governor's Island or a little below.

A. I don't think there is any question there that I could answer. The previous answers have been as to population, and these conditions appear to apply to sewage.

Q. In your direct testimony you stated that these regions had been growing very rapidly, did you not?

Mr. Riker: No, he didn't say that.

A. No.

Q. You don't recall stating that the regions had grown very rapidly?

A. Not the region of the Bronx and Queens.

Q. How about the Harlem River region?

A. I offered the suggestion without knowing definitely that Manhattan might be growing very rapidly in that portion which drains into the Harlem River, but that I thought the Bronx was growing rapidly.

Q. How would you relieve the sewage conditions of the Bronx?

A. The sewage condition of the Bronx relates to more than one outlet, and the principal trouble now with the sewage of the Bronx is due to its discharge into the Harlem River, and I offered two suggestions as to relieving the Harlem River, which would take care of a part of the sewage of the Bronx.

Q. What part of the sewage would you take to Riker's Is-
336 land?

A. Enough of the sewage that now enters into the lower part of the Harlem River to relieve any present or any objection of the near future, and I stated not to Riker's Island alone, but either to Riker's Island or to Ward's Island.

Q. Which do you think would be the better location?

A. The better location would be at Riker's Island. As far as the discharge of the sewer is concerned, but there may be other considerations which would make Ward's Island the more appropriate.

Q. You believe that is a practicable plant?

A. Yes.

Q. But you would use multiple outlets, would you?

A. I certainly would in any of these discharges of large quantities of sewage, so as to avoid entirely the local nuisance.

Q. Are the changes in salinity in the Upper Bay of New York gradual or sudden, or are they uniform?

A. What does this relate to, element of time or element of depth?

Q. Any time, every time, we are dealing with a question that takes in three hundred and sixty-five days in a year.

337 Mr. Riker: The question is objected to on the ground that it is indefinite and does not indicate as to what the uniformity is directed to, in what respect it is uniform.

Commissioner Maher: The objection will be noted.

Q. Can you answer that?

Mr. Riker: The question is objected to on the ground that if the changes are uniform, they are not changes.

Commissioner Maher: The further objection of counsel will be noted.

A. Changes in the salinity of the waters of the Upper Bay of New York occur during the year owing to the change in the quantity of water discharged by the Hudson River and from fresh water streams tributary to the Upper Bay. As the quantity of fresh water decreases, the waters of the Upper Bay became more saline. I do not recall how quickly these changes take place, but it is my general judgment that when there are times of low water, the changes take place rather gradually, because of the great quantity of fresh water between the mouth of the Hudson and Albany. In regard to changes in the salinity of the water from the top to the bottom, there is a decided change at times when the flow of the Hudson is very large.

338 When there is an average flow, as I have already stated in my testimony, the per cent of the land water at the surface is about forty-five and the per cent near the bottom is about thirty-three. In very dry times, after a sufficient time has elapsed, the percentage of land water decreases to somewhere in the neighborhood of twenty, and at such times there is very little difference in the salinity of the water at the surface and at the bottom.

Q. In your direct testimony you gave those figures of forty-five per cent land water at the surface and thirty-three per cent land water at the bottom, did you not?

A. Yes.

Q. So that in asking you as to the salinity of the waters of the Upper Bay of New York, as to whether those changes in salinity were sudden or gradual, or were uniform, throughout the year, I put a

question that you already had given some thought to the subject matter of?

A. Yes.

Q. Where did you get the figures that you have just given, Mr. Stearns as to the percentages of land water and sea water?

A. From the reports of the Metropolitan Sewage Commis-
339 sion of New York.

Q. And what part of the year did those percentage figures on salinity cover?

A. I think many parts of the year; I do not recall exactly.

Q. Were you interested with Mr. Freeman in his report—I think you testified a little earlier with regard to that Charles River basin—were you interested in the report made by Mr. Freeman in 1903, on pollution in ocean and tidal estuaries?

A. I had no part in the making of that report. I had made a previous report, on the subject myself.

Q. And did it cover that question of sudden changes in salinity and the effect that those sudden changes had on the digestive capacity of the water?

A. No.

Q. Have you read Mr. Fuller's book on sewage disposal?

A. No.

Q. What effect had these changes in salinity on the bacteria that disintegrated such organic matters as are discharged through the sewers or as sewage effluents into waters like those of the Upper Bay of New York?

A. I have had no occasion to study that matter.

Q. You realize that those bacteria are the ones that disintegrate the organic matter after the organic matter is discharged into
340 these waters?

A. Only a very general knowledge of it.

Q. How does oxygen act on such organic matter in order to mineralize it as you testified in your direct?

A. In many cases it seems to act very quickly; I haven't studied into the agency through which it does so.

Q. Does it do it directly by a chemical union or indirectly through biological action?

A. It seems to me in some cases as if it must act directly to a large extent.

Q. In these filtration works that you prescribed for Baltimore, did you ever examine any of the deposited matter on these stones?

A. No.

Q. Do you know whether or not the agency that really applies the oxygen is bacteria?

A. I know it is thought to be in those cases.

Q. What effect has the sudden changes in the salinity on the bacteria that disintegrate organic matter?

A. That is outside of my line of knowledge.

Q. Let me call your attention to what Mr. Fuller states and I read from page 333 of his works on "Sewage Disposal" published in 1912:

"That with violent changes of salinity many of the beneficent low forms of life would be killed off; that it was not practicable to secure such thorough mixture of the fresh upland water with the
341 salt Harbor water as to avoid differences of specific gravity which would prevent vertical circulation and thus prevent water in the lower layers of the basin from coming into contact with the air whereby their dissolved oxygen could be renewed."

That is based upon the report of Mr. Freeman and the experimental work that was done by the biologist, Mr. Clark, and the other members of the Commission. Does that accord with your views, or do you take issue with that view?

Mr. Riker: The question is objected to on the ground that it is immaterial and irrelevant, the witness having already said that he had no knowledge on the subject.

Commissioner Maher: The objection will be noted.

A. I have no knowledge of the first part of this that relates to the killing off of beneficent forms of life, but in regard to the second paragraph——

Q. Marked "C"?

A. Marked "C"—there is a new information now that entirely supersedes that; that is, it was not thought a short time ago to be feasible to mix sewage with salt water to the extent of preventing it from ponding at the surface of the salt water, but now it is known that it can be prevented, and such a mixture achieved that
342 there will be subsequently vertical circulation due to currents and winds and waves.

Q. And you understand from Mr. Freeman's report that he distinctly states there that the admixture prevents vertical circulation?

A. I understand from this statement—I don't know what it comes from in Mr. Fuller's book, but that is not applicable in the present case. It may have been in some particular case.

Q. If you will turn to page 333, you will find the beginning of the discussion, under the heading "fresh water basin versus salt water basin comparative advantages" on page 334, he gives the chemist's report in digested form, Mr. H. W. Clark.

Mr. Riker: Is there any question? I move to strike the statement of counsel out of the record if there is no question based on it—there being no question based on it.

Mr. O'Sullivan: The statement was given in answer to a question put by the witness, and the motion is opposed to.

Commissioner Maher: Note the motion of counsel for the defendant, and the objection of counsel for the complainant.

Q. I call your attention to a further statement on page
343 337 of Mr. Fuller's book:

"Salt water layers remained beneath the fresh water layer; that vertical circulation and reaeration of the lower layers of the water were thereby cut off, and that these deeper layers were devoid

of oxygen and populated almost solely by the anaerobic or putrefactive bacteria and would in warm weather continually give off hydrogen-sulphide and other foul smelling gases."

Do you find that as I read it?

A. Yes.

Mr. Riker: I move to strike the question and answer out of the record, on the ground that it is an attempt on the part of counsel to introduce the contents of a book into the record, by asking the witness questions in regard to it.

Commissioner Maher: Note the motion and objection of counsel for the defendants.

Q. Do you agree or disagree with the statement of Mr. Fuller's book which is taken from the report of Mr. Freeman?

Mr. Riker: The question is objected to on the ground that it does not appear that the witness knows that this report is taken from the statement of Mr. Freeman, or the report of Mr. Freeman.

Commissioner Maher: The objection will be noted.

344 A. Now that I see what it relates to and the conditions under which the statements are made, the condition to which the statements refer, I do agree with the statements, because this is a case where the fresh upland water referred to comes in on the surface of an enclosed body of water, that is, a basin of water held by means of a dam, and in such case as that, if salt water is in the lower layers, then there are no currents except the slight current produced by the upland water coming in, it would prevent vertical circulation, but that condition has no relation whatever to conditions where there are strong currents and the vertical circulation is produced by the currents keeping the top and bottom layers well mixed.

Q. Are there strong currents in the Upper Bay of New York?

A. Yes, sufficiently strong, as shown by the results, to mix the upper and lower waters to a nearly complete extent when the amount of upland water is small, and to a moderate extent when the amount of upland water is large.

Q. What is the velocity of the ebb current in New York's Upper Bay?

A. Without looking at a report, I should say it was from two to three feet a second at the strength of the tide.

345 Q. What distance would that be an hour?

A. That would mean from one and three-tenths to two miles per hour.

Q. Have you had an opportunity to consult Colonel Black's report, who has been head of the Harbor Line Board of New York for many years, as to the Harbor conditions here, and as to the velocities of flow and currents?

A. No. I have seen one report by Black and Phelps since I have been in this room, but did not have a chance to look into the question of currents.

Q. Colonel Black, in 1909, June 22, in a report to General Wood, gave the mean velocity of the ebb currents as about one-quarter mile per hour.

Mr. Riker: I move that the statement of counsel as to the contents of a report of Colonel Black which is not in evidence, be stricken out.

Commissioner Maher: Note the motion of counsel for defendant.

Q. On what do you base your estimate of the velocity of the ebb current in the Upper New York Bay?

A. It was based mainly on memory of what I have read which memory may not be accurate; based in part on observations made at Robbins Reef, which is a part of the New York Upper Bay.

346 Q. Did you conduct any float experiments or other means of determining velocities of the currents at any time in the Upper Bay of New York?

A. No.

Q. In what did your observations consist?

A. In the examination of statements regarding currents in the Metropolitan Sewerage reports, and in a paper written by Mr. H. De B. Pasons for the American Society of Civil Engineers.

Q. What does he give the velocity of the ebb current of the Upper Bay of New York as?

A. At the lower end of the Upper Bay, that is, at the Narrows, he says that the average velocity of the swiftest surface thread during the tidal period on ebb is 1.34 knots—that must be per hour. That would be translated into ordinary miles, by increasing it to a little more than one and one-half miles per hour as the average of the whole ebb tide, and the velocity at the strength of the tide would be much more.

Q. Are you aware of the fact that there have been conditions under which there have been no change of tide in New York Harbor?

A. No.

Q. Do you believe such conditions possible?

347 A. Not for any long time; I have known cases where the tide didn't recede much after high tide, when there was an extremely strong easterly wind in some harbors, and that might apply here.

Q. In the plans that you have suggested for the disposal or relief of the Harlem sewage problem, you suggested sedimentation works on Ward's Island or on Riker's Island and screening and sedimentation, and a further chemical treatment; is that correct?

A. I said that was suggested as a possibility of a further chemical precipitation.

Q. Did you make any suggestion for chemical precipitation to the Passaic Valley Sewerage Commissioners?

A. I did not; that feature was not within my province.

Q. Are you familiar with other bodies of water than those at Boston and in New York Harbor and as to the deposits from sewage or sewage effluents in those bodies of water?

A. I am very well acquainted with the Potomac River in which the sewage of Washington in the District of Columbia is discharged,

and also know well the Chicago drainage canal into which the sewage of Chicago is discharged.

Q. There the flowage is one way, is it not; there is no tidal range?

A. If you refer to Chicago, yes; if you refer to Washington, no.

Q. What is the tidal range at the City of Washington in
348 the Potomac?

A. I do not know, but it is only a few feet, as I recall it, from 1888.

Q. Will sewage preserve its identity for long distances after discharge into bodies of tidal waters?

A. It depends entirely upon how it is discharged and the circumstances.

Q. Do you know of any cases where sewage has preserved its identity for long periods?

A. It is a question of what one would call long periods; it preserves its identity below the Moon Island outlet for about an hour and a half, and the reason of that is the method of discharge.

Q. The discharge at Moon Island is extremely offensive near the outlet, I understood you to state?

A. Yes, and for quite a long distance from the outlet, due to the character of the discharge at the outlet and the vast volume that is discharged.

Q. In using that term "vast volume," Mr. Stearns, what do you estimate the volume at each discharge at Moon Island to be?

A. I was thinking more particularly of the rate of discharge; the superintendent at the works told me that it was at the rate of a million gallons a minute, and when he first began to discharge the basin, and that agreed closely with what I should judge
349 myself; that is, there is a discharge at the rate of about 800,000,000 gallons during the whole of the discharge, and it goes much faster at the beginning. That million gallons a minute would be at the rate of 1,440,000,000 gallons per day.

Q. And how many minutes does the discharge occupy?

A. It used to be about three-quarters of an hour; I don't know definitely now, I should say about an hour and a half; they have doubled the size of the basins, and that sewage is thoroughly septic; I should say so.

Q. Will you describe for the purpose of this record what you mean by septic sewage?

A. I mean sewage from which all of the dissolved oxygen or practically all is gone, and which is putrefying and giving off gases, and judging by the color, includes some sulphuretted-hydrogen. I may not be using the term "septic" exactly in the right way, but that is what I had in mind,—what I have stated by the definition.

Q. That is what I am getting at. What is the age of the sewage, approximately, at Moon Island?

A. I don't know that.

Q. About eight hours?

A. I think it is much more than that.

Q. Ten hours?

350 A. Besides the period of storage; this is a pretty rough estimate, but it would average as much as eight hours in addi-

tion to the five hour period in the basins; that is, the time in the basins is ten hours for some of it, and zero for the rest, averaging five.

Q. And that would travel what distance before it was discharged, approximately?

A. About a dozen miles, for the most distant point.

Q. How far will the Passaic Valley sewage travel before it is discharged?

A. I do not know.

Q. How long is the Passaic Valley trunk sewer?

A. I do not know that.

Q. What condition would you expect the Passaic Valley sewage to be in when it reached the disposal works on the Newark Meadow?

A. I cannot judge as to that, because I do not know the relations between the most distant travel and the large quantity which comes in near the Newark Meadow here in Newark.

Q. What is the grade of the Passaic Valley trunk sewer?

A. I haven't examined it.

Q. Have you seen any of the plans or specifications of the Passaic Valley Trunk Sewer project, including the sewage disposal works and the trunk sewer?

351 A. I do not recall seeing any plans of the trunk sewer, except that I may possibly have glanced at some plans, but I did look carefully at the plans of the disposal works.

Q. What condition as to comminution would you expect the Passaic Valley Sewage to be in when it reached the disposal works?

A. I think it would be to a considerable extent comminuted except for portions that come from the lower portion of the city.

Q. And as to septicity, what condition would you expect it to be in?

A. I don't know; that is, I am not sufficiently acquainted with the subject to know whether the fresh sewage coming in at Newark would furnish dissolved oxygen to prevent the septicity of the other sewage that comes from a longer distance.

Q. The Nut Island outlet, the sewage there is offensive, is it not, at the point of its discharge and near by?

A. I should not call it particularly offensive even at the point of discharge; there is an odor there.

Q. Mr. Riker asked you about Nut Island. Is Nut and Peddock's Island one and the same place?

A. No, Nut Island is the place where there is a screening plant, coarse screens, and the pipes lead from Nut Island for a mile

352 into the Harbor, but the point where the end nearest to Peddock's Island discharges is only about a quarter of a mile from Peddock's Island, and the other is 1,500 feet away from Peddock's Island.

Q. Is there a trunk sewer outlet at Peddock's Island?

A. No, it is nearer Peddock's Island, but no part of the works touch Peddock's Island, merely that the line of outfall from Nut Island passes reasonably near Peddock's Island.

Q. What temperature would you expect the Passaic Valley sewage

to register by the time it reached the outfall at Robbins Reef in Summer weather?

A. In the hot summer weather I should say about seventy-four degrees Fahrenheit.

Q. What would you expect in the months of July, August and September to be the temperature of the water at flood tide in the Upper Bay of New York?

A. About sixty-five degrees.

Q. How many pumpings would the Passaic Valley sewage be subjected to before it reached the disposal works and the pumping station on the Newark Meadows?

A. Some of it only to one pumping, and I understand there are other pumps on some of the branch sewers.

Q. Have you seen any of the plans of the syphons for transporting the sewage across the Passaic River to the trunk intercepting sewer?

353 A. No, sir.

Redirect examination.

By Mr. Riker:

Q. What was the special occasion for the high degree of purification provided at the Baltimore Works?

A. The law under which the sewerage works were to be constructed required that no sewage should be drained into Chesapeake Bay, and then there was a decision of the Commission as to what that law meant, and it was decided by the Commission, and the instructions were given to the engineers that they meant the greatest possible purity that could be attained.

Q. Do you know the occasion for a law requiring that high degree of purity?

A. It was the action of the oyster industry in the Chesapeake Bay, and if I might add, the political power of the man that ran the oyster industry.

Recross-examination.

By Mr. O'Sullivan:

Q. Are you familiar with the complaints that have been made of oyster pollution by the sewage of Washington and the inspections and examinations instituted by the Federal Government?

A. No.

Adjourned to Thursday, June 12th, 1919, at 10.30 a. m.

354 United States Supreme Court.

THE PEOPLE OF THE STATE OF NEW YORK, Complainants,

vs.

THE STATE OF NEW JERSEY and PASSAIC VALLEY SEWERAGE COMMISSIONERS, Defendants.

Continuation of Testimony Taken in the Above-entitled Cause Before James D. Maher, Commissioner Appointed by the Supreme Court of the United States, at the Office of Messrs. Riker and Riker, 164 Market Street, Newark, New Jersey, on Thursday, June 12th, 1919, at 10.30 a. m.

Present: Counsel as before stated.

GEORGE C. WHIPPLE, sworn for defendants.

Direct examination.

By Mr. Riker:

Q. Where do you live?
A. Cambridge, Massachusetts.
Q. What is your profession?
A. Sanitary Engineer.
Q. Will you state your education and experience as a sanitary engineer?

355 A. I was graduated from the Massachusetts Institute of Technology in 1889. I began work on the Boston water works and was in charge of the laboratory at Chestnut Hill from 1889 until 1897. From 1897 until 1904 I was in charge of the Laboratory of the Brooklyn water works and the New York water works, after the consolidation of the two cities. In 1903, I was department engineer of the commission on additional water supply of New York City. In 1904 I formed a partnership with Mr. Allan Hazen, and since that time have been a member of the firm. The name of the firm now is Hazen, Whipple and Fuller. In 1913, I think it was, I became the Professor of Sanitary Engineering in Harvard University, and at the present time that is my principal occupation. During the so-called agreement between Harvard University and the Massachusetts Institute of Technology I was Professor of Sanitary Engineering in both institutions. I am also the secretary of the School of Public Health of Harvard University and the Institute of Technology. I am a member of the Public Health Council of Massachusetts State Department of Health. I have recently received a commission in the Reserve of the United States Public Health Service as senior sanitary engineer. I have recently been appointed chairman of a committee on sewage disposal of the Na-

tional Council of Research. I am chairman of the Sani-
356 tary Commission of the City of Cambridge. I think that those are my principal appointments.

Q. Have you had any education or training in chemical work, Mr. Whipple?

A. Yes, sir. In connection with my work in sanitary engineering, I have had charge of laboratories for a considerable period of time, both chemical and biological, and have devoted considerable part of my time to these problems the last twenty-five years. I was the secretary of the Committee on Standard Methods of Water Analysis of the American Public Health Association when it issued its first report.

Q. When was that?

A. I don't remember exactly, Mr. Riker; I think it was about ten years or so ago.

Q. Have you done any personal chemical work in connection with the training or otherwise?

A. Yes, sir, I have been not only doing work on water analysis personally, but I have been teaching those subjects in connection with my work at Harvard and at the Institute of Technology.

Q. Outside of your position in Harvard University at this time what do you do as a member of the firm of Hazen, Whipple and Fuller; what is the line of work?

357 A. Generally speaking, my part of the work, which has come to me, is that which has related to the quality of water, purification of water, studies of water pollution, methods of sewage treatment, and in general, I may say, the analytical side of the business.

Q. Have you anything to do with construction work in connection with your firm?

A. I have never taken an active part in that phase of our work.

Q. Have you published any scientific works or pamphlets?

A. I am the author of the following books: Microscopy of Drinking water, Typhoid Fever, Value of Pure Water, State Sanitation—three volumes, Vital Statistics, and I am one of the editors of Fresh Water Biology; I have also had published many scientific articles and pamphlets and reports in various cities where I have done work.

Q. Under an order made in the suit in which you are testifying, on the tenth day of March of this year, testimony was allowed to be introduced under the third paragraph of that order, as follows:

"Additional testimony to the extent reasonably practicable within the times herein limited, as to the present degree of pollution of the waters of New York Harbor, including those parts affected or to be affected by the proposed Passaic Valley sewerage system and by the sewage of the City of New York, and the change, if any, in the degree of such pollution since the time to which the testimony heretofore taken related."

358 In what way Mr. Whipple, can the degree of pollution of the waters of New York Harbor be ascertained and tested?

A. By inspection of the waters themselves and by the collection and analysis of samples of the water from the Harbor.

Q. What do you do with the samples collected?

A. There are various tests which might be made of those waters, including chemical, bacteriological and biological tests, but I have found, and it seems to be generally agreed that the most useful single test is that of the amount of oxygen dissolved in water. I would say that other tests of importance, however, are color, odor and turbidity and physical tests.

Q. What observations have you made of the waters of New York Harbor, particularly the waters, in more confined description, of New York Bay and the Hudson River and the East River?

A. In times past, you mean, or recently?

Q. All the observations that you have had an opportunity to make.

A. My first studies of the water of New York Harbor were made in 1903, in connection with the work of the New York Commission on Additional Water Supply. At that time the tidal studies were made by the department under my charge and the tide
350 gauges were established at various points in the Hudson River, and some studies were made, and many studies were made of the salinity of the water in the Harbor and in the Hudson River. In 1906 I again studied the condition of the Harbor in connection with the report which my partner, Mr. Hazen, made to the City of Paterson on its sewage disposal problem. In 1907 I did some work for the Metropolitan Sewerage Commission, and on May 28th of that year made an inspection of the East River—a rather detailed inspection at that time. In 1909 I took samples of water and made tests for dissolved oxygen, at various places in the Harbor, for the Passaic Valley Sewerage Commission.

I have had occasion at intervals to go over the Harbor since that time, particularly in 1916, when I made a study of the problem of garbage disposal at Staten Island for the State Department of Health. I have seen the Harbor many times unprofessionally, as I crossed the East River on the Wall Street Ferry daily for a year or two.

On May 3rd, 1919, I made an inspection of the New York Harbor, starting from the Battery, going up the Hudson River, through the Harlem River, down the East River, then across the Upper Bay, through the Narrows to a point opposite Coney Island,
360 and then back to the Battery.

On May 16 I was again on the Upper Bay and made an inspection of Buttermilk Channel and Gowanus Canal.

Q. Now, with reference to the appearances of the water in New York Harbor, what are the principal factors involved?

A. The most conspicuous factor relating to the appearance of the water, and the one most likely to be observed by the passing traveller, is the litter. This was true in 1907, and I found it to be even more true in 1919, due, as I assumed, to the extraordinary amount of shipping now in the Harbor, and on account of the unusual activities along the shore incident to the War. This litter has consisted largely of wood in the form of chips, boards, logs, old

boxes and barrels and crates, but there was also hay and straw, and all sorts of miscellaneous litter, including occasional dead animals and garbage.

The second conspicuous factor is the oily scum which comes from various sources. In 1907 the surface of the water in the East River north and south of the gas works in Manhattan was commonly covered with sheets of oil. This varied all the way from iridescent sleeks to a rather dense yellowish filament; they imparted an odor to the water.

361 Another place where oily films were given, in 1907, was the Upper Bay from Constable Point to the Statue of Liberty, in the Gowanus Canal and in the Newtown Creek. There were a few places in the North River, but these were not as conspicuous as at the other places mentioned.

On May 2, 1919, the oily sleeks were conspicuous for their absence in the East River. Some oily sleeks were observed on that date in the vicinity of Robbins Reef Light, and between that point and Constable Hook.

Mr. O'Sullivan: That was this year?

Witness: Yes, 1919.

On May 16, a large amount of oil was observed in the waters of the Upper Bay, in the Buttermilk Channel and in the Gowanus Bay. These were specially conspicuous in Gowanus Bay near the gas works, and apparently consisted of what is commonly known as water gas tar, presumably discharged from these gas works. These oily patches appeared to be drifting out of the canal from time to time, or were discharged through the conduit of the channel, so as to affect the water in the vicinity of the Battery as well as along the Brooklyn shore and the Narrows.

From the observations made in 1919 it appeared to me that the two most important sources of oil at the present time are

362 the Gowanus Canal and the oil works at Constable Point.

Q. Now, in the appearance of the water of New York Harbor, does the turbidity play any part?

A. At certain seasons it plays a very important part. I may say that at all times it plays an important part, but at certain seasons it is perhaps the controlling factor. The Hudson River is a turbid stream, and at times the turbidity in the Hudson River is probably higher—that is, higher than that of the sewage of the city.

Q. In what respect does the turbidity differ in appearance in the water from sewage discharges?

A. The turbidity in the Hudson River gives a brown appearance to the water—a brownish green, perhaps I might say and it prevents one from seeing far into the water. The water looks almost muddy at times, and in this respect it seems to me that the New York Harbor water is very different, indeed, from the water of many harbors on our Atlantic Coast; it is certainly very different from the water in Boston Harbor, with which I am familiar, because there we have no large turbid streams discharging into Boston Harbor and controlling the appearance of the water, whereas,

in New York Harbor, the turbidity of the Hudson River af-
363 fects all of the water in the Harbor, but notably that in the Hudson River and in the Upper Bay. I believe that if there were no pollution, either in Boston Harbor or in New York Harbor, the water of New York Harbor would be much more unsightly in appearance than the water of Boston Harbor. On the other hand, there is perhaps some advantages in this turbidity, in that it tends to obscure any sewage which may enter the water.

Q. What appearance does the discharge of sewage into the Harbor give to it?

A. Locally it gives it a turbid appearance; the color is more gray —grayish brown, rather than a greenish brown, and it tends to become black or blackish in the slips where the pollution is considerable. These black colors are limited in place and are purely local; they are also intermittent. Some of this blackish color is due at times to the stirring of mud deposits in the slips.

There is one other factor which influences turbidity, and that is the microscopic organisms which are at times found in the Harbor water, and which I found to be very abundant on May 3, 1919. These microscopic organisms, while they add to the turbidity, preventing anyone from looking into the water, are to a certain extent a purifying agent. As during sunlight they produce oxygen gas, thus adding to the oxygen supply in the Harbor.

364 Q. Will you give a little more in detail the results of your inspection of New York Harbor on May 2nd and May 3rd, of this year?

A. On May 2, 1919, the water at the Battery was turbid, and contained a considerable amount of litter. The usual evidences of sewage pollution were seen near the New York shore, in the middle of the Hudson River the water showed no evidence of sewage pollution, yet was quite turbid. This turbidity evidently came not from the sewage, but from the Hudson River itself. The turbidity persisted as far up the Hudson river as we went, namely, to the mouth of the Harlem River, and I am in general familiar with the turbid appearance of the Hudson River throughout its course.

Along the Hudson shore where the big steamers were docked, the water showed some evidence of pollution. There was some oily sleek and there was much litter strewn on the water. No other great change was observed in the character of the Hudson River water up to Spuyten Duyvil, except that there was less litter strewn about.

The Harlem River was apparently largely filled with Hudson River Water at the time we went through. It had the appearance of being a little more turbid than the Hudson River.

365 The channel to the west of Ward's Island contained clearer water, and seemed to be evidently less influenced by the water of the Hudson River.

The water in the East River was much cleaner than it was ten years ago, as I remembered it, and the absence of oily sleek was noticeable.

In the lower East River the water showed signs of pollution along the shore, but not in mid-stream.

The water in the Upper Bay was somewhat less turbid than in the North River.

In the vicinity of Robbins Reef light, and between that point and Constable point, there were large areas covered with oily sleek which evidently came from the oil works. These were more conspicuous in the Kill von Kull. These oily sheets were floating out into the Upper Bay and were observed along the Brooklyn shore.

The water in the lower Bay was fairly clear, much clearer than the water in the Upper Bay. The water along the Brooklyn shore, in the vicinity of Bay Ridge and from there north of Governor's Island, showed decided evidence of pollution. The condition of the water appeared to be less satisfactory than it was ten years ago as I remembered it, and the difference appeared to be
366 due to the increase in shipping along the water front.

When I say "less satisfactory," I refer largely to the additional amount of litter in the vicinity. The litter observed on that day consisted largely of boards and chips and stakes and other pieces of wood, but it also contained more or less garbage and miscellaneous matter.

On May 16, 1919, the water in Buttermilk Channel, and along the Brooklyn shore between Red Hook and the Brooklyn Bridge, showed marked signs of oily sleeks on the surface, and these oily sleeks, extended pretty well from the East River across to the Battery and up and down Governor's Island.

Q. Have you made any observations of the General appearance of the waters of New York Bay and Hudson River and East River prior to 1919?

A. Yes, I made them, as I have already stated, I kept a record of the inspection which I made on May 28th, 1907.

Q. How does the condition of the waters as observed by you in May 1919, compare with the condition as you observed and shown by the record in 1907?

A. The water in the East River appeared to be in a better condition in May, 1919, than it was in May 1907 and by better condition I mean there was less odor from the oily films of the surface,
367 and the films themselves, were less conspicuous. I think the ordinary observer seeing the water on the two days, would give the opinion that the water was in a better condition this year than it was twelve years ago. In the Hudson River I do not think that the difference was very marked. Nor do I think that the difference was very marked in the water of the Upper Bay. I think that the turbidity was—or that the record shows that the turbidity was a little greater in May 1919, than it was when I made the inspection in 1907. I would like to withdraw that statement because I am comparing the Hudson River with the East River, which I ought not to do.

Q. You have no note of 1907, of the appearance of the Hudson River?

A. No, I haven't a memorandum of that. This inspection was

of the East River, I mean the one of which I kept a record. I am speaking only from memory as to the condition of the other parts of the Harbor.

Q. In what way were the inspections made; I mean by that, in what character of boat?

A. In 1907, as I recollect, we had a small launch which started from the Battery and went up the East River as far as forty-sixth street or thereabouts, on the New York side, then across over to the Brooklyn side, and returned to the Brooklyn Bridge and
368 back to the Battery, and taking special note of the condition of the water, opposite various streets and opposite various industrial establishments along the shores.

In 1919, we had a launch and a more general inspection of the water, not looking so much for the details of pollution as for the general appearance.

Q. Did you make any observation on the odors of the water as connected with sewage discharges?

A. In 1919, we collected a few samples which shook and smells of. I do not think that we kept any very definite record of those odors.

Q. Were the odors of sewage on that inspection marked at any point that you can state from memory or otherwise?

A. There were slight odors of sewage noted at various places. The odors were not at all offensive. But they would be called sewage odors by one who was familiar with sewage. I do not think that anyone riding over the water in a boat would notice these odors, except very near the shores and where there was obvious pollution.

Q. I think you said you took some samples, to determine various matters of turbidity and odors, and particularly turbidity?

A. Particularly turbidity. The turbidity records I have
369 here; the color and chlorine and I may add, the temperature of the water.

Q. Those were taken on May 16 of this year?

A. Those were taken by me on May 3, 1919.

Q. Did you make any tests for color and chlorine yourself?

A. Yes, sir, on May 3, 1919, I collected samples of water at various places in the Harbor, to determine their temperature, their turbidity and their apparent color, by the use of the United States Geological Survey apparatus, and made analyses of the samples of water, to determine the chlorine and the amount of oxygen dissolved.

Q. What method was used to determine the amount of dissolved oxygen?

A. The so-called Winkler method.

Q. Will you describe that briefly?

A. It consists of a collection of the water in a bottle holding a quarter of a liter, or thereabouts, in such a way that it could not be contaminated or influenced by the atmospheric oxygen, and manganese-sulphide, an acid, was then added on the boat at the time of the collection; these bottles were then taken to my office in Forty-

second street and the test was completed by titration, in the usual way, using hyposulphite of sodium, starch &c.

Q. Is this an approved method?

370 A. This is the standard method recognized by the Committee on standard methods of the American Public Health Association, the committee of which I was Secretary when the report was adopted.

Q. What other tests were made in connection with the test of dissolved oxygen?

A. One or two samples were tested to determine what I called their true color, uninfluenced by the turbidity present, and also tested to determine the number of microscopic organisms present.

Q. What was the object in making those tests?

A. To ascertain the cause of the turbidity and to see whether or not those organisms were present, because they have something to do with the oxygenation of the water. These tests were made of only a few samples of the water, however, merely enough to give a qualitative test.

Q. Were any tests made for the chlorine content and the temperature of the water?

A. Yes, sir, the chlorine was determined; samples of the water were collected and taken to my office and the tests for chlorine were made there by the usual method—the one described in the report of the committee on Standard Methods, to which I have alluded.

Q. Made under your supervision?

371 A. Yes, sir and by me. The temperature was observed at the time when the samples were collected.

Q. A record was made of the temperature of course?

A. And a record of the temperature made.

Q. What is the purpose of making these particular tests for chlorine and temperature?

A. Because the amount of oxygen which water will hold in solution depends in part upon the temperature of the water and upon its salinity, and the salinity of the water is measured by the amount of chlorine present.

Q. What effect has salinity on the absorption of oxygen?

A. It decreases the amount of oxygen which water can hold in solution. It is difficult to see just what effect it has on observation of oxygen from the air.

Q. Its effect, then, is on the solubility of oxygen in the water?

A. Yes, which affects the amount which it is possible for the water to dissolve.

Q. What do you mean by the saturation of water by oxygen?

A. When water contains as much oxygen as it can contain at a given temperature and salinity, it is said to be fully saturated with oxygen, that is, to be 100 per cent saturated.

Q. How do you determine the question of whether water is saturated with oxygen or not?

372 A. Fundamentally that is determined by experiment by trial.

Q. Will you state where the samples to be submitted to these tests

were taken on the date that you have named, May 3rd, I think it is, or May 2nd?

A. Sample A was collected on the south side of pier A of the North River. At that station two samples were collected one at the surface, or about a foot below the surface, and the other at a depth of twenty feet.

Station B, where samples were collected at depths of one foot and forty-six feet;—the one foot sample, being called, for convenience, the "surface sample",—was about 600 feet west of pier A in the North River.

Station C, where samples were collected at depths of one and sixty-three feet, was about half way between Ellis Island and the north end of Governor's Island.

Station I, where samples were collected at depths of one and sixty feet was about 1,500 feet east of Robbins Reef lighthouse.

Station J, where samples were collected at depths of one and twenty-four feet, was opposite seventy-ninth street, Bay Ridge and about 200 yards from the shore.

Station K, where samples were collected at depths of one and fifty feet, was near the Narrows—I may say in the Narrows, off Rosebank, some 200 yards from the shore.

373 Station L, where samples were collected at depths of one and sixty feet, was also in the Narrows, and about 200 yards off the Quarantine Dock.

Station N, where samples were collected at depths of one and twenty-four feet, was in the East River at the Market Street pier, south of the Manhattan Bridge.

Station O, where samples were collected at depths of one and nineteen feet, was in the East River at the western end of the Williamsburg Bridge.

Station Q, where samples were collected at depths of one and sixteen feet, was in the East River, under the Brooklyn Bridge, on the East side.

Q. Who selected the points of collecting the samples?

A. I did.

Q. And were the samples on the day as to which you are testifying, taken in your presence?

A. They were, and in many cases by me.

Q. Why did you select these particular points for taking the samples?

A. Because on November 3, 1909, samples had been taken at these places and tested in a similar way.

Q. By you?

A. By me.

Q. What is the importance, so far as sewage pollution is
374 concerned, of the oxygen content of the water into which it is discharged?

A. The organic matter of sewage is always ultimately disposed of by oxidization, and when the sewage is discharged into water, the oxygen dissolved in the water plays a part in this oxidization.

Q. You say it plays a part; what part?

A. It plays the chief part, I should say.

Q. Directly or indirectly?

A. To some extent directly, but more largely, perhaps through the action of bacteria and other organisms, it is a biochemical phenomenon to a large extent.

Q. Have you any opinion, Mr. Whipple, of the limits of safety in the matter of reduction of oxygen content in Harbor waters?

A. My answer would depend largely on what is meant by safety, but my opinion from a study of the whole subject is, that as long as any dissolved oxygen remains in the water, polluted with sewage, there is not likely to be any serious trouble; that is to say, not until the oxygen of the water is completely used up do we begin to get the putrefactive conditions which are very objectionable. Of course, in practice, it would not do to allow the amount of dissolved oxygen in the water to become exhausted, that is, to be reduced to zero.

Q. Why not?

375 A. Because it would be too near to the danger limit. In this, as in most things, it is necessary to maintain a certain factor of safety, and right here comes in opportunity for difference in judgment of different engineers. Some engineers place the amount of oxygen necessary to be maintained as a standard at a very high point, say as high as seventy per cent; some say fifty per cent, some say thirty, some would go lower than that, and say twenty. My personal opinion is that it is not necessary to maintain as high a percentage of saturation as a working standard as a good many engineers have thought. My feeling is that if the working standard of twenty, or even something less than twenty, was maintained, no unsatisfactory conditions would be likely to result. I would wish to exclude from my answer, however, those local conditions which often arise within the slips, where there may be very intense pollution at times. I am referring to what may be called the broad waters of the Harbor.

Q. Is your conclusion affected in any way by the presence or absence of sludge at the bottom of the water, on the flow of the Bay?

A. Yes, that has to be taken into account, if sludge is allowed to accumulate one must have probably a little higher working
376 standard than if the sludge is removed with a fair degree of regularity, that is to say, the working standard must be adjusted to the method of operation.

Q. If the oxygen content of the water is reduced to thirty per cent, will not objectionable odors be produced by that water?

A. I believe not from the water itself. I know as a matter of experiments in the laboratory, if you take diluted sewage and hold it in bottles until the biochemical processes proceed to the point where the oxygen is reduced to thirty per cent, that no serious or offensive odors will develop in that bottle, and those odors will not begin to develop until the oxygen has completely disappeared.

In practice, however, it sometimes happens that where in the Harbor or off some shoal the oxygen is reduced to thirty per cent, odors are observed from gases resulting from decomposition of sludge at

the bottom or from the decomposition of deposits on the piles all along the shores.

Q. Returning, Mr. Whipple, to the samples taken in 1919, under your direction or in your presence, on May 2nd, or May 3rd, whichever the date was, were those samples subjected to the oxygen test to which you have testified?

377 A. Yes.

Q. Under your direction or by you?

A. Yes, sir.

Q. Have you the results of those tests in written form?

A. I have them in the form of a blueprint table, entitled "Dissolved oxygen, New York Harbor, May 3, 1919."

Q. Who made the table?

A. The original of the table was made by me, and it was typewritten by my secretary.

Q. Was it compared by you with the original?

A. Certain columns were, not all.

Q. What do the different columns indicate in that table?

A. The first column shows the field at which the samples were collected; the next column shows the depth at which the samples were collected; the next column shows the time of day at which they were collected; the next column shows the temperature at which they were collected; the next column shows the apparent color of the water, as determined by the United States geological survey apparatus; the next column shows the turbidity of the water; the next column shows the chlorine in parts per million; the next four columns all relate to the amount of dissolved oxygen, one showing the amount of dissolved oxygen present in parts per million, another showing

378 the amount of dissolved oxygen present in cubic centimeter of oxygen per liter of water; the next showing the amount of oxygen which would saturate the water, of equivalent temperature and chlorine and the next showing the per cent which the amount of oxygen actually present was of that required to saturate it. Then follow two columns showing the comparison of sea water and so-called landwater, and finally the true color of two samples of water determined after the turbidity had been removed.

Q. Have you got that in such shape that it can be separated and offered in evidence?

A. Yes, sir.

Q. The blue print which you hand me, is that taken from the table from which you have been reading?

A. It was made from this table I have a tracing and the blue print is made from this tracing.

Mr. Riker: I offer the table in evidence.

(Copy handed to Mr. O'Sullivan.)

Cross-examination.

By Mr. O'Sullivan:

Q. How did you arrive at the depth at which you took the samples?

A. The depth was determined by marks on the rope to which the bottle was attached, and the line was held as nearly vertical as possible, when the samples were collected, but this of course,
379 must be regarded as only approximately correct, because it was not always possible to maintain this line in a vertical position, due to the movement of the boat and the water.

Q. How did you determine, Mr. Whipple, the location at which you took the samples?

A. Merely by sight, by the use of a map and by location of the eye.

Q. You didn't use an Azimuth compass?

A. No, we used no scientific instrument for determining the location.

Q. What was the tidal condition at the time; was it ebb or was it flood, at which you took these samples?

A. The height of the tide at Governor's Island was determined from the daily paper of the morning, and is given at the foot of the table. It was high water at Governor's Island at 11:37 A. M. and at Sandy Hook at 11:8 A. M.

Q. You used no meteorological tables other than those that are outlined in the daily newspapers, is that right?

A. That is right. We took figures that were given there.

Q. What standard did you take for your color test?

A. The so-called apparent color was determined by a glass standard or series of glasses which had been previously calibrated and which were placed at the ends of an open tube in order that
380 light passing through them might be compared with the light passing through a similar tube filled with the water being tested.

Q. You used figures in the column under the title "Apparent color" figures 35, 40, 42 and similar figures; what do those indicate, and what standard did you use in indicating those figures?

A. Those figures refer to the scale known as the platinum standard, which is the recognized standard for color determination of the Committee on Standard Methods of the American Public Health Association and those glasses which we used had been previously calibrated so as to correspond to the solutions which I used in that test; these calibrations having previously been made by me personally.

Q. How many of those calibrated implements did you use in determining the figures for the apparent color?

A. We used a set of five glass disks which varied in color; sometimes they were used singly, sometimes one was placed over the

other, but they were so graduated that one can obtain almost any color, or quite a range of colors, for purposes of comparison.

Q. But with these five standard color disks, you have gotten approximately eight varieties in figure determinations for the apparent color; how did you get the intervening figures?

381 A. By estimation between the different combinations of the disks.

Q. Did you use a thermometer for determining the temperature?

A. We did.

Q. How did you arrive at the turbidity figures given in the column here under that heading?

A. We used what is known as the platinum wire method of the United States geological survey—a method by which the platinum wire is lowered into the water and the height of the water read on the lowering taken, the observation being taken just at the point where the wire disappears from view. It is a well recognized standard method.

Q. Did you use a salinometer in arriving at the chlorine determinations here?

A. No, sir.

Q. How did you arrive at the figures given under the heading of chlorine?

A. By titration with standard sulphur-nitrate solution, using potassium chromate as the indicator—a recognized standard test for chlorine.

Q. You confined your oxygen determinations entirely to those obtained by the Winkler method?

A. We did, yes, sir.

382 Q. Did you make any effort to determine the percentages of nitrates in the samples that you examined?

A. No, sir.

Q. Or nitrates?

A. No, sir.

Q. I noticed in the last column, under the heading "True Color" you give two figures; what did those indicate?

A. The sample collected at the surface at Station B had a true color of 12.

Q. What does that signify?

A. That means that after the turbidity had been removed by filtration through paper, the color of the water as determined by the platinum scale was 12, which is a lower figure than the apparent color given in the previous column, 12, which is influenced by the amount of turbidity present.

Q. What does that indicate, that figure 12, under the heading of "True Color," for the third sample indicated in the table?

A. It indicates the brownish stain which the water has. That sort of stain which often comes from swamps or swampy waters, the apparent color is made up of this brownish stain, and in part by the turbidity.

Q. How does it happen, Mr. Whipple, that there are only two samples in which you give the true color?

383 A. Because we only carried back to our laboratory and to my office a large bottle from those two stations, one taken from the Hudson River and one taken from the East River. I wanted to see how much of the apparent color in each case was due to turbidity and how much was real color. I thought that these two samples, one from each, would be sufficient to indicate that.

Q. How did you determine the percentages of sea-water and land water under the columns headed by the two titles I have just mentioned?

A. By assuming that the sea-water contained 18,000 parts per million of chlorine, and the per cent of sea-water was obtained by dividing the chlorine found by 18,000.

Q. Do you know of any other methods for oxygen determination than the Winkler method, Mr. Whipple?

A. Yes.

Q. What are the other ones?

A. There is one that is quite common—fairly common—known as the Levy method; that is not nearly as common as the Winkler method, and is very seldom used.

Q. Are you familiar with the Lette-Adeney method?

A. I am in a general way, but I have never used it practically. There is also, of course, a physical method, by boiling off the——

Q. The absolute method?

384 A. Yes, that I am familiar with, but those methods are not as practicable as the method which I used.

Q. Did you take into consideration, in making these determinations, the rainfall of the immediately preceding period at the time you secured the samples?

A. No, sir.

Q. Are two samples from a given location a reliable method of determining the average oxygen percentage contained in the water in that region?

A. They may or may not be, depending upon the mixing of the water. Usually we are limited by practical considerations in the number of samples which we can take.

Mr. O'Sullivan: I make objection to the admissibility of that exhibit, on the ground that it hasn't been surrounded with sufficient safeguards.

Commissioner Maher: Note the objection of counsel for complainant to the reception of the exhibit, and the exhibit will be inserted in the record and marked Defendants' Exhibit No. 8.

Def'ts' Ex. 8.

Dissolved Oxygen.

New York Harbor, May 3, 1919.

Station.	Depth.	Time, P. M.	Temp. C.	Appar. color.	Turbidity.	Chlorine, PPM.	Dissolved oxygen. PPM.	Dissolved oxygen. CCpL.	Dissolved oxygen. Sat. PPM.	% Sat.	% Sea water.	% Land water.	True color.
A	Surf...	12.20	10.1	35	17	12,750	6.81	4.76	9.79	69.6	70.8	29.2	
A	20'...	12.27	9.9	40	20	10,850	6.83	4.77	10.01	67.7	80.3	39.7	
B	Surf...	12.40	10.9	42	25	9,250	....	....	....	....	51.3	48.7	12
B	40'...	12.50	9.4	..	..	11,500	6.70	4.67	10.13	66.1	63.9	36.1	
C	Surf...	1.10	11.0	35	18	10,600	7.26	5.07	9.85	73.6	58.9	41.1	
C	63'...	1.25	9.8	28	..	12,600	7.81	5.45	9.78	79.9	70.0	30.0	
I	Surf...	1.50	12.0	35	14	10,500	7.99	5.52	9.66	81.8	58.3	41.7	
I	60'...	2.00	9.5	28	12	12,800	8.33	5.82	9.91	84.2	71.1	28.9	
J	Surf...	3.00	10.0	20	18	12,050	7.40	5.17	9.89	74.8	67.0	33.0	
J	34'...	3.10	9.5	20	18	13,600	7.98	5.57	9.82	81.3	75.6	24.4	
K	Surf...	2.20	9.8	20	10	12,900	7.95	5.55	9.75	81.5	71.7	28.3	
K	50'...	2.30	9.2	15	10	14,000	8.76	6.12	9.89	88.5	77.8	22.2	
L	Surf...	2.35	10.0	20	10	12,400	4.45	3.10	9.85	45.2	68.9	31.1	
L	60'...	2.50	9.5	18	..	13,100	8.58	5.98	9.88	86.9	72.8	27.2	
		A. M.											
N	Surf...	11.10	11.0	40	20	11,100	6.71	4.68	9.79	68.5	61.7	38.3	
N	24'...	11.20	10.0	..	..	11,850	....	....	....	....	65.8	34.2	
O	Surf...	10.40	10.0	40	25	9,500	6.66	4.64	9.98	66.7	52.8	47.2	15
O	19'...	10.45	10.0	..	..	10,400	6.58	4.59	10.08	65.3	57.8	42.2	
Q	Surf...	11.30	10.0	40	20	9,050	6.62	4.62	10.03	65.9	50.2	49.8	
Q	16'...	11.30	10.0	..	..	10,000	6.57	4.58	10.13	64.8	55.6	44.4	

	A. M.	P. M.
High tide at Governors Island.....	11.37	11.56
Sandy Hook	11.08	11.31

No. 3, Original. New York vs. New Jersey. Defendants' Exhibit No. 8.

JAMES D. MAHER,
Commissioner.

386 Further direct examination.

By Mr. Riker:

Q. You made some sampling and tests for dissolved oxygen in 1909, I think?

A. Yes, sir.

Q. Did you make those samplings yourself?

A. Yes.

Q. And the tests were made by you or under your immediate direction?

A. They were.

Q. What character of test did you apply at that time?

A. They were made by the same methods which were used in 1919.

Q. You have before you, I think, a table; what is that table, Mr. Whipple?

A. A table which shows the dissolved oxygen at various points of New York Harbor, November 3, 1909.

Q. The various points to which you refer, are they the same general points that were included in the table for your experiments in 1919?

A. The stations marked by letters correspond on the two dates, and there were certain stations on November 3, 1909, which were not covered by the work in 1919.

Q. Will you indicate those stations which are not covered by the table of 1919?

A. Station D, was 1,000 feet east of the north end of Ellis
387 Island. Station B was at the mouth of the Gowanus Canal at the pier on the north side. Station F, in the Gowanus Canal, 200 yards below Hamilton Avenue bridge, near 18th Street.

Station G, in the Gowanus Canal, opposite Center Street.

Station H, in the Gowanus Canal, at the Ninth Street bridge.

Station M, in the Kill von Kull, opposite the copper works.

Q. Are there corresponding lettered stations shown on the table for 1919?

A. No, sir.

Q. They are omitted, are they?

A. They were omitted in 1919, on that date.

Q. The other stations are the same as in 1909?

A. Yes.

Q. Who prepared the table?

A. I did.

Q. From what source did you get your information to prepare it?

A. From data which I obtained at the time the samples were collected and analyzed.

Q. Was this table that you have before you made at or about the time of taking the samples and analyzing them?

388 A. This particular table is a copy of my former records, which I have compared with my old records.

Q. And the various columns, Mr. Whipple, do they correspond with the columns shown on the table for 1919?
A. Yes, sir.
Q. Have you a blue print of that table?
A. Yes, sir, (producing same).
Q. All samples shown were taken on the same date, I think, Mr. Whipple, in 1909?
A. Yes, sir.
Q. And that was what date?
A. November 3, 1909.
Q. This blueprint was made when?
A. Within a couple of weeks.
Q. Of this time or of the time of making the table?
A. Of this time.
Q. From what?
A. From the original, which I have before me, which original I have compared with my old records.

Mr. Riker: I offer this table of the 1909 observations and examination in evidence.

Cross-examination.

By Mr. O'Sullivan:

Q. In making the oxygen determination on November 3, 1909, Mr. Whipple, did you solely use the Winkler method?
389 A. Yes.
Q. Did you make these determinations yourself?
A. Yes, sir.
Q. When you say that you compiled these tables from data obtained at the time, from whom did you obtain that data?
A. From the former report which I made to the Passaic Valley Sewerage Commission.
Q. So it was your own work?
A. Yes, sir.
Q. Did you secure these samples yourself?
A. Yes, sir.
Q. And they were all secured between 10.45—I don't know whether that is a. m. or p. m.
A. That should have been put in, that is 10.45 a. m.
Q. —And 4.06 p. m.?
A. Yes.
Q. You obtained these twenty-seven samples yourself?
A. Yes, sir.
Q. And when did you make the determinations?
A. My recollection is that the work was all done on the boat, but it may be that the titration of the dissolved oxygen was carried on in our laboratory; I don't remember, as ten years have elapsed.
Q. What was the tidal conditions that day, November 3,
390 1909, at the time of the taking of those samples?
A. On November 3rd, according to the nautical almanac, high water occurred at Sandy Hook at 11.46 a. m.; low water oc-

curred at 6.19 p. m.; at Governor's Island, high water occurred at 12.11 a. m. and low water at 6.49 p. m.; at Hell Gate, the high water was at 2.07 p. m., and low water at 8.37 p. m.

Q. With regard to the column under the heading "Depth", you use the abbreviation for "surface"; what does that actually mean as to depth?

A. That the sample was taken a little way below the surface, and the practice was about one foot. I have no doubt it varied more or less, according to wave condition.

Q. What is there in this table that shows the location of the station and its distance from other points?

A. There was nothing in the table which shows the location; those locations I have already read into the record.

Q. I have six of them; there are about twenty-seven here.

Mr. Riker: Those six are the omitted ones that don't appear on the second table of 1919, do these tables as given under the head of Station A, &c., do they correspond as to the point at which the sample was secured, with the preceding table that has been
391 put in evidence, with the exception of the stations which you distinctly testified were at different points?

A. Yes, as nearly as it was possible for us to locate them from the previous description.

Q. Did you arrive at the percentage of sea and land water in a similar manner to what you did in the preceding table?

A. Yes, sir.

Q. And the column under the heading "color" and "turbidity" were arrived at from similar standards to the ones you have already testified to in regard to the other table that was taken this year?

A. The ultimate standards were the same; I don't remember just now whether we used the liquid color standards or whether we used the glass standards. I think, as I recall it, that we used the same method for both, on both days.

Mr. O'Sullivan: I object to the admissibility of the tables, as being misleading and not valuable for the purposes of comparison.

Commissioner Maher: Note the objection of counsel for the Complainants. The exhibit will be received and marked Defendants' Exhibit No. 9.

New York Harbor, Nov. 3, 1909.

Station.	Depth.	Time.	Temp. C.	Color.	Turbidity.	Chlorine, PPM.	Dissolved oxygen.			% Sat.	% Sea water.	% Land water.
							PPM.	CCpL.	Sat. PPM.			
A	Surf.....	10.45	9.7	8	5	14,300	5.98	4.18	9.69	62.0	79.4	20.6
A	20'.....	10.52	10.7	10	5	14,600	5.97	4.17	9.45	63.0	81.1	18.9
B	Surf.....	10.57	11.1	9	5	13,600	6.07	4.24	9.49	64.0	75.5	24.5
B	46'.....	11.02	10.6	7	5	14,600	....	....	....	....	81.1	18.9
C	45'.....	11.20	10.5	7	3	14,400	5.67	3.96	9.51	60.0	80.0	20.0
C	Surf.....	11.27	10.9	11	3	14,400	5.85	4.09	9.43	62.0	80.0	20.0
C	63'.....	11.35	....	10	3	15,000	6.48	4.53	....	....	83.3	16.7
D	Surf.....	11.45	10.8	10	1	14,200	6.05	4.27	9.48	64.0	78.8	21.2
D	30'.....	11.51	10.6	9	5	14,000	5.69	3.98	9.47	60.0	81.1	18.9
E	Surf.....	12.13	11.1	7	2	15,300	5.84	4.08	9.30	63.0	85.0	15.0
E	16'.....	12.20	10.6	5	1	15,000	5.91	4.13	9.43	63.0	83.3	16.7
F	Surf.....	12.47	11.7	25	10	14,900	1.82	1.27	9.24	19.7	82.8	17.2
F	22'.....	12.51	11.1	17	8	15,400	2.75	1.92	9.29	30.0	85.6	14.4
G	Surf.....	1.30	15.8	..	52	12,700	0.	....	....	....	70.6	29.4
G	14'.....	1.35	13.1	..	32	14,000	0.	....	....	....	77.8	22.2
H	Surf.....	1.45	16.7	..	60	12,000	0.	....	....	....	66.7	33.3
H	14'.....	1.50	13.9	..	50	13,800	0.	....	....	....	76.7	23.3
I	Surf.....	2.15	10.6	6	1	16,000	7.11	4.97	9.32	76.0	78.9	21.1
I	60'.....	2.20	10.3	4	1	16,000	7.17	5.01	9.38	76.5	78.9	21.1
J	Surf.....	2.40	10.6	5	2	16,000	6.84	4.78	9.32	73.0	78.9	21.1
J	34'.....	2.52	10.3	3	3	16,300	7.42	5.19	9.35	79.0	90.6	9.4
K	Surf.....	2.58	10.6	5	3	15,500	7.22	5.05	9.37	77.0	86.1	13.9
K	50'.....	3.10	10.3	2	..	16,600	7.70	5.38	9.31	83.0	92.2	7.8
L	Surf.....	3.17	10.6	6	4	15,700	6.97	4.87	9.35	75.0	87.2	12.8
L	60'.....	3.27	10.3	3	3	16,800	7.61	5.32	9.29	82.0	93.3	6.7
M	Surf.....	4.00	10.8	6	8	14,800	6.42	4.49	9.41	68.0	92.2	17.8
M	40'.....	4.06	10.6	5	9	14,800	6.10	4.27	9.45	64.5	82.2	17.8

393 Further direct examination.

By Mr. Riker:

Q. Are you able to make any comparison of the condition of the water of New York Bay from the two tables which have been put in evidence in this case?

A. I can compare the two results, yes.

Q. Will you compare the results?

A. Do you mean by station?

Q. I think, perhaps, if you have it in such form before you that you can, it will be more satisfactory; yes.

A. At station A, at the surface the amount of oxygen present on November 3, 1909, was 4.18 cubic centimeters per liter; on May 3, 1919, at the same place, it was 4.76. The corresponding figures, at a depth of twenty feet, at this station, were 4.17 and 4.77.

At station B, in 1909, the oxygen present was 4.24 at the surface. At station B the oxygen was not determined in 1919, at Station B, depth forty-six feet, in 1909, the oxygen was not determined, but at this depth in 1909, it was 4.67.

At station C, surface in 1909, it was 4.09; in 1919, it was 5.07. At station C, depth sixty-three feet it was 4.53 in 1909, and 5.45 in 1919.

At Station I, surface, 1909, it was 4.97; at the same place, in 1919, 5.52. At station I, depth sixty feet 1909 5.01; in 1919, 5.82.

394 At station J, surface, 1909, 4.78; in 1919, 5.07. At station J, thirty-four feet, 1909, 5.09; 1919, 5.57.

At Station K, surface 1909, 5.05; 1919, 5.55. Station K, depth fifty feet, 1909, 5.38; 1919, it was 6.12.

Station L, surface 1909, 4.87; 1919, 3.10. Station L, depth sixty feet, 1909, 5.32; 1919, it was 5.98.

There was no corresponding sample on M.

Q. So far as the pollution of the water of Upper New York Bay and the Hudson River and the East River, as indicated by these samples at the two different times, are you able to state any conclusion as to the comparative pollution?

A. I do not wish to generalize too much from the two sets of samples only, but in so far as these samples go, they show that the amount of dissolved oxygen in 1919, May 3, was greater in almost every case than at the corresponding stations and depth on November 3, 1909.

Q. Is the comparison entirely satisfactory, Mr. Whipple?

A. No, sir.

Q. Why not?

A. Because the dates do not correspond, because the locations were only approximate, but were the best which could be made because the chlorine conditions were not quite the same; the percentages of salt and fresh water were not quite the same on the two dates.

I think that so far as methods are concerned, the two sets
395 of samples are comparable fairly.

Q. In order to get a thoroughly satisfactory comparison, Mr. Whipple, what would be necessary, in your judgment?

A. A collection and analysis of a considerable number of samples collected on different days, at different stages of the tide, and extending over a considerable interval of time.

Q. So far as 1909, is concerned, did you make observations of samples on more than one day, as a matter of fact?

A. A few samples were collected and analysis made on November 4 and November 5, 1909.

Q. Were there any samples taken in May, 1909, by you?

A. Not by me.

Q. In the year 1919, Mr. Whipple, have there been submitted to you for your examination any other analysis of samples taken at the stations appearing on D8?

A. On May 9, May 16, May 23, and May 31, samples of water from the Harbor were collected at the same stations, and tests and analysis made by Mr. Gordon M. Fair, working under my direction. Mr. Fair is instructor in Sanitary Chemistry in Harvard University, teaching the course in water analysis there, and has been employed by me in connection with various analytical investigations, and was directed by me to collect samples at these points and make

396 the tests in the same way in which they — made on May 3rd. Mr. Fair was present with me on May 3rd, when I collected samples and made tests myself. I believe that the results obtained by him are fairly comparable with those which I myself obtained on May 3rd, in fact, Mr. Fair assisted me in making the tests on May 3rd. In addition to those, Mr. Fair collected another set of samples from the North River, the East River, in the New York Harbor, on May 23. These points, however, did not exactly correspond with those which I previously indicated by the letters.

Q. What, in your opinion, is the best test of the effect of pollution upon the waters into which sewage is discharged?

A. The test for dissolved oxygen.

Q. What do you mean; do you recognize the term biochemical depletion?

A. There are various ways of expressing the amount of dissolved oxygen in water; one is to give the weight of the oxygen in a certain volume of water; this is commonly described as milligram per liter, which is approximately equivalent to parts per million. Another way is to give the cubic centimeter of oxygen per liter of water; that tells the volume of oxygen present in a given volume of water.

397 Another way is to find the percentage of—or the per cent which the amount of oxygen present, either by weight or volume, bears to the amount which could be present if the water was saturated, either by weight or volume. That is commonly called the per cent of saturation.

These different methods have their various uses, and they can be combined in two or three different ways to show different things.

You asked about the biochemical depletion. That is the difference between the amount of oxygen actually found and the

amount which would be found, if the water was saturated with oxygen at a given temperature and salinity. It might be expressed either by volume or weight, but I have usually chosen to express it by volume, that is, in so many cubic centimeters of oxygen per liter of water.

Q. Is that biochemical depletion largely due to the pollution?

A. Yes, it will add to pollution and it reduced the amount of oxygen used up by the polluting substances in the course of this biochemical action, which I have previously referred to.

Q. Taking that as the basis for determination of the effect of pollution, from the records before you, are you able to deter-

398 mine whether the biochemical depletion of oxygen in the East River was greater in 1919, than in 1909?

A. From these records, I should say that it was not substantially greater in 1919, than in 1909. I believe there were places where it was a little greater.

Q. Have you determined the relative biochemical depletion of oxygen at the mouth of the Hudson River, from the records before you, in 1919, as compared with 1909?

A. I have, and there is not a great amount of difference between them.

Q. You attempted to make the same determination with the waters at Robbins Reef light?

A. Yes.

Q. And with what result?

A. With the conclusion that the figures do not indicate a substantially greater depletion of oxygen at that point in 1919, than in 1909.

Q. You attempted to make the same determination of the condition of the waters at the Narrows?

A. I have.

Q. With what result?

A. I may say no greater depletion in 1919, than there was shown in 1909.

Q. Do you consider this determination, this comparison, a fair scientific one?

399 A. If you wish to compare the effect of the sewage on the amount of oxygen used up in the course of the biochemical processes.

Q. What are the sources from which the waters of New York Bay replenish the dissolved oxygen which may have been used in sewage disposal or otherwise?

A. The chief sources of oxygen are the dissolved oxygen in the entering sea-water and in the entering waters of the rivers, but another important source is the oxygen of the atmosphere, which is absorbed, dissolved, by the water, and which absorption takes place at an increasing rate as the percentage of saturation falls. There is one minor source of oxygen which at times may be important, and that is the oxygen given off by the microscopic organisms found in the water, such organisms, for example, as I found to be present on May 3, 1919.

Q. What is reaeration?

A. Reaeration is usually considered to be the absorption of oxygen from the atmosphere by water as the surface of the water comes in contact with the air.

Q. One of the conditions you already testified to, under which this reaeration proceeds more rapidly, and that is the reduction of the dissolved oxygen in the recipient water; am I right about that?

A. Yes, sir; the less oxygen there is in the water, that is, the greater difference there is between the oxygn in the air
400 and water, the more rapidly will the oxygen be taken up by the water.

Q. What other factors add to the efficiency of the process of reaeration of water?

A. The wind is a very important factor. Any factors which cause the water to be rapidly mixed—the tidal currents, temperature currents, temperature variations between the surface and the bottom, and the movement of the wind itself over the water, which produces ripples and waves, which causes the water to break into drops and spray, and thus greatly increasing the surface exposed. The effect of the screws of propellers of steamers in churning the water, and in general all those influences which produce movement in the water of the Harbor.

Q. Is the process of reaeration an important one in the maintaining of the safe margin of dissolved oxygen in water into which sewage is discharged?

A. It is a very important factor, and in some situations it seems to be the most important one.

Q. To what situations do you now refer?

A. There are instances where sewage is discharged into streams, with the result that the oxygen falls to a low percentage, where after a certain flow or certain reaeration produced by rapid currents, there is an absorption of oxygen from the air which
401 restores the oxygen content of the water; there being apparently no other source of this oxygen excepting that which is derived from the air.

Q. Can you name some instances of this?

A. I have had occasion to observe a number of instances of that sort. For example, in Philadelphia it has been found that a short distance below the City the oxygen at times falls to twenty, often to ten per cent of saturation but that after a further flow the oxygen was restored to fifty or sixty or seventy per cent, something of that sort. In the Chicago Drainage Canal the oxygen falls as one leaves Chicago, until near the lower end, it becomes at times entirely gone, and then after a flow over the dam there is an aeration which restores the oxygen to a considerable extent in the water.

I could name a number of similar places in Massachusetts, but I think the principal is one which is quite generally recognized—certainly recognized in streams. I remember in particular some work which I did a number of years ago in Pittsburgh, where as one passed down the stream the oxygen fell to a fairly low figure

—I should say ten per cent or twenty per cent of saturation, and where after a further flow the oxygen was restored, and the
402 only reason for the restoration appeared to be absorption from the air.

Q. In your opinion does the process of reaeration play any considerable part in the problem of maintaining the waters of New York Bay in a safe condition, so far as oxygen is concerned?

A. Yes, sir, I think it does, and I think that should the population increase greatly, and should there be a greater tendency toward a depletion, this factor would become increasingly important.

Q. Have you attempted to make any computation of the number of contributing individuals the waters of New York Bay can safely dispose of the sewage of?

A. Yes, I have made some computations.

Q. What margin of dissolved oxygen do you take as the basis for your computation, if you take any margin?

A. I haven't figured it out in exactly that way. I should regard a working standard as something in the vicinity of fifteen to twenty parts per million, perhaps, but I have no very definite opinion on that matter; I know of no way by which one can fairly state what is reasonable, whether ten or twenty or thirty. I feel sure that it would be unreasonable to require a standard very much higher than those figures.

Q. On what, then, have you made your estimate of the
403 population that might safely have its sewage discharged into New York Bay?

A. Merely by taking the amount of oxygen which is commonly regarded as sufficient to oxidize the sewage, based on a certain dilution which has come to be more or less acceded by engineers, and upon the amount of oxygen which seems to be available in the new water which enters the Harbor from the sea and from the rivers, and the absorption, the reasonable estimate of the absorption of the oxygen from the air. I have not attempted to state any particular figure for a limit of population.

Q. Can you state an approximate figure?

A. Only in a very general way. I made a computation, but I don't seem to find that before me. I should have to look for my memorandum, because I answered that question.

Q. Have you made any effort to determine the increase in population of New York City from 1909 to 1919?

A. Yes, sir.

Q. With what result?

A. Basing my computation on the Federal Census records, I have estimated that the population of New York City, that is, the legal limits of New York City, in 1909, was 4,649,300 and in 1919, 5,966,000 an increase during the ten years of 1,347,000.

Q. An average of what per year?

A. If you should divide that by ten, and estimate an equal
404 increase, it would be 134,700 persons per year. I don't know that we are quite justified in doing that, however, especially

as the census of the State gives figures which are quite at variance with the Federal figures.

Q. I hand you a memorandum which I received from you, Mr. Whipple, at the bottom of page five, and ask you whether that is the memorandum which you said you had to look for?

A. This is a memorandum which I have made, which gave some studies on this subject, but which didn't arrive at any definite conclusion, which appeared to me to be entirely satisfactory. Nevertheless, it has seemed to me that from a study of the dissolved oxygen conditions, the water entering the Harbor contains enough oxygen to dispose, without nuisance, of the population which would vary all the way from 7,500,000 to 30,000,000 people, according to the standard which was set, and in my judgment the fair estimate will be much nearer 30,000,000 than it would be 7,500,000. I do not give this view, however, as a definite figure. It might be considerably more; it certainly would be considerably more than 30,000,000 if a reasonably low standard of dissolved oxygen were permitted, and which I believe would be fair, and if a proper allowance is made for the oxygen dissolved from the atmosphere.

405 I do not see how any one can state with any authority the exact amount of reaëration which will occur in the Harbor, and and being able to state this, you cannot tell the population which can be allowed to contribute sewage to the Harbor without causing offensive conditions. I may say that I have looked over some of the estimates which have been made, and my judgment is that most of them are small—much too small, and that the figure would probably be nearer twenty-five or thirty million than ten to fifteen million.

Q. In the matter of disposing of sewage from a large population such as you have been testifying to, are you or are you not assuming diffusion and dispersion of the sewage?

A. I am estimating a fairly good dispersion of the sewage through the water. I do not have in mind conditions which are likely to arise, and which have already arisen, around the immediate points of discharge.

Q. You are now speaking of New York City?

A. Of New York City, or even on the New Jersey side.

Q. Do you know what the contributing population of New Jersey is to the pollution of New York Bay?

A. I looked up the populations of Bayonne, Jersey City and Hoboken in 1910, and found the sum of these populations to be 393,648; I do not know just what proportion of this population con-

406 tributes sewage directly to the Harbor but I suppose a round number of 400,000 in 1910 would not be unreasonable, which would probably have to be increased by a certain amount for the present year.

Q. Do you know what the population of the Passaic Valley Sewerage District is?

A. I have made some estimates of population for the Passaic Valley Sewerage District, starting with the figures which were published in 1905 in the report of my partner on the Paterson Sewage disposal, which figures showed that the population of the Passaic Valley Sewer-

age District was 574,264 taking the same places, the census of 1910 gave the population as 736,449 in 1915, taking the figures for the New Jersey State census, the population was 805,630. That would mean that between 1900 and 1905 the annual increase in population in the District was about 2.38 per cent per year. That is, assuming that the population in 1900 was 510,000 which I think was approximately correct, that between 1905 and 1910, the annual increase in population was 2.07 per cent, and that between 1910 and 1915, it was 1.83 per cent.

Q. In fixing the population which can safely discharge its sewage into New York Bay, have you assumed any treatment of the sewage?

A. I assumed no treatment, although I don't wish to be
407 recorded as having stated any very definite limit. I don't see that anybody has any grounds for stating any limits, excepting in the most general sort of a way.

Q. You spoke of the methods now in practice in New York City of discharging its sewage into the waters of New York Bay, in your answer to a late question. What is that method, as you have observed it?

A. It consists in discharging the sewage from the ends of the sewers which are located often at the back ends of the slips, sometimes at the pier heads, sometimes slightly submerged, but sometimes at the water level, or a little above it, with practically no method of treatment, except in one instance which I happened to see.

Q. What improvement could you suggest as to the method of discharging sewage of New York City into the Bay?

A. The improvement would be to carry the sewer outlets far enough into the streams so as to prevent the sewage from becoming pocketed or from accumulating at the shore; far enough so that there would be a band or strip of fairly clean water between the outlet of discharge of the sewage and shore line.

Q. Has depth of discharge any part in the safe disposal of sewage into the waters of New York Bay?

A. Yes, I think much better results are obtained by discharging sewage into a harbor at a considerable depth. A good deal of
408 experience has been accumulated along that line during the last ten or fifteen years, and even during the last year.

Q. Can you point out any place at which that experience has been gained?

A. We have studied this question very carefully in Massachusetts. I say "We" I mean the State Department of Health, of which I am a member of the council, and in particular we have had occasion to notice the discharge of the Boston sewage into the Harbor at three points: The Moon Island discharge, which was installed some thirty-five years ago, where the sewage flows out upon the surface, or near the surface; the discharge at Nut Island, constructed some twenty-five years ago—some fifteen years ago, I guess it was, where the sewage is discharged at the bottom, or near the bottom, and the discharge at the Deer Island, constructed some twenty-five years ago, but only last year changed, so that it now discharges near the bottom; whereas, it formerly discharged near the surface. I was familiar with the ap-

pearance of the Harbor around the Deer Island discharge before the change was made, and I have seen it recently, and I can testify to the great improvement which has occurred in the condition of the Harbor near that point of discharge as the result of putting the sewage in at the bottom instead of at the top. And as the result of
409 spreading the sewage over a considerable area instead of putting it all in at one place. I might refer also to the deep discharges at New Bedford and at Swampscott as examples of the benefit of deep discharge.

Q. Have the multiple outlets any part in the more satisfactory results?

A. Yes, sir, I think they play an important part in the method in which the sewage is discharged from the outlets. It is also an important element. It is important that the sewage should be mixed as quickly as possible with the water as it emerges from the outlet.

Recess.

Q. I was asking, Mr. Whipple, when we adjourned, with reference to the discharge of sewage by submerged outlets. Are you familiar with the plans of the discharge outlets,—the outlets of the Passaic Valley sewer at Robbins Reef?

A. I have seen the plans, Mr. Riker; I have studied them in a general sort of way, and have also seen the outlet devices for mixing the sewage with the water. I haven't made a careful study of that phase of the question.

Q. From what you have seen, do you think that it is a desirable and effective plan for the discharge of sewage?

410 A. It looks to me like a very-well-thought-out plan, and one that could be effective in mixing the sewage, partly because the outlets are deep and pretty well scattered over a considerable area, and because the method by which the sewage will be discharged from the orifice, namely, with a whirling or centrifugal motion, which will tend to flow the sewage out into the water.

Q. Do you think it a desirable device to apply to the discharge of New York sewage at submerged outlets?

A. I don't know that that would be applicable to New York for the reason that this is for a large volume of sewage, whereas, in New York the sewers, as a rule, discharge much smaller quantities, and such elaborate devices wouldn't be needed in New York, probably.

Q. Have you personally observed the conditions at the Deer Island outlet in Boston Harbor since the multiple submerged outlets have been installed?

A. Yes, sir.

Q. And had you observed the conditions before that was done?

A. Yes, sir.

Q. What is the condition now as compared with the conditions then?

A. The sewage as it appears at the surface is less conspicuous now than it was formerly.

Q. Conditions are improved then, are they?

411 A. The conditions are, I should say, very much improved.

Cross-examination.

By Mr. O'Sullivan:

Q. Have you ever constructed or operated a sewage disposal plant, Mr. Whipple?

A. I never constructed one; I have never had definite charge of a sewage disposal plant. I mean official charge.

Q. What is the objective of sewage disposal systems as a whole?

A. To get rid of the sewage of a community in an inoffensive and safe, inconspicuous way.

Q. How many sewage disposal systems are you familiar with, Mr. Whipple?

A. I cannot answer that by number; I am familiar with practically all of the disposal plants in Massachusetts, most of them being intermittent sand filters, but some being trickling filters. I am familiar with the various plants in New York State, in a good many cities of the country. I don't know whether you want me to name them; I could probably name several dozen if you wanted me to. I made a special study of the sewage disposal problem in England, in 1905,—probably forty or fifty plants over there; also on the continent. And I am generally familiar with most of the large
412 and important plants in the United States.

Q. What I wish to get at, Mr. Whipple, is the different systems of treating the organic matter that we describe as sewage using that generic term?

A. I am familiar with practically all of the systems that are commonly used; broad irrigation, and intermittent sand filters, contact beds, trickling filters, septic tanks, two story or Imhoff tanks, chemical precipitation, activated sludge method, disinfection; I think that covers the principal ones.

Q. Which of those systems or methods of sewage disposal is the most efficient, in your opinion?

A. That depends upon the basis of—what you regard as efficient. If the removal of suspended matter is taken as the basis, then there is no doubt that the filtration of the sewage through fine material is the most efficient, although the new method of activated sludge gives promise of being one which will produce a clear—a reasonably clear effluent. If the oxidization of the organism is taken as the basis, then the method of sprinkling filter or trickling filter occupies an important place. If the removal of bacteria is the criterion, then filtration and disinfection are perhaps the most important. In other words, it is impossible to answer your question definitely as to the efficiency of different processes.

413 Q. Assuming that a sewage disposal treatment has to be devised for a comminuted highly septic sewage, which of those systems would you expect to render the greatest degree of efficiency and render the best effluent as the result of the treatment?

A. Again, the question of the result must come in to control the decision. If costs are disregarded, the area required, local condi-

tions, etc., are disregarded, then the method of intermittent sand filtration is perhaps, all things considered, the best one.

Q. If as a sanitary engineer, Mr. Whipple, you were given the duty to devise a sewage disposal system that would render an effluent from which visible suspended particles would be absent; that would not yield deposits in the waters into which it was discharged; that would not give rise to odors of putrefaction of organic matters; from which there would be an absence of grease or color on the surface of the water into which the effluent was discharged, and from which no injury to public health would be occasioned as the result of the discharge of the sewage, and which effluent would not reduce the dissolved oxygen in the body of water into which it was discharged. Which of those systems would you advocate to yield you an effluent of that character?

414 Mr. Riker: I object to the question on the ground that it is not cross-examination, and counsel reading from Exhibit No. 135, being the stipulation between the United States and the State of New Jersey, upon which he was not examined in chief, and as being immaterial and irrelevant.

Commissioner Maher: The objection of counsel for the defendants will be noted.

Mr. Riker: Objected to on the further ground that the question is not directed to the stipulation which has been referred to in its terms, but is a modification of it, and deals with a condition which does not appear anywhere in the testimony in the case.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I am unable to answer, Dr. O'Sullivan, because it would all depend upon the nature of the body of water into which the effluent was to be discharged. It would be impossible to decide upon the choice of a system without taking that into account. As well as the other conditions which you have mentioned.

Q. The question, Mr. Whipple, went to the character of the effluent itself and not into the body of water, and I now ask you which of those systems would produce an effluent of the character described in my preceding question?

415 Mr. Riker: The question is objected to on the ground that it does not conform to the record, the record showing that the question asked by counsel did refer to the effect in part, of the discharge, into the recipient body of water.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. I still think it impossible to answer your question, because it is impossible to separate the effluent from the body into which it is discharged.

Q. And you know of no system that will produce an effluent of the character described in my preceding question?

Mr. Riker: The question is objected to on the ground that the question asked does not describe an effluent, but describes an effluent in part and the result in part.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. I will not say that I knew of no systems which would accomplish that.

Q. I asked you what system will produce such an effluent?

A. Various systems would produce that result, I believe. Depending upon the water into which the effluent was discharged, both in quantity and character.

Q. What are those sewage disposal systems that will pro-
416 duce an effluent such as I described in my preceding question.

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. If the body of water into which the sewage was discharged was sufficiently large and had a considerable movement, then a method by which the sewage were treated in tanks and by the use of screens, would, I believe, be sufficient to produce the results which you mentioned, but under other conditions where the body of water was smaller, where the motion was less then some more elaborate plan might be necessary, such as a tankage, coupled with sprinkling filters and screens, or treatment by intermittent sand filters.

Q. As a sanitary engineer, Mr. Whipple, has it ever come to your knowledge that effluents have been produced by sewage disposal systems that are capable of being drunk without injury?

A. I know that effluents have been drunk; I don't think that that has been done regularly, but I have personally ventured to drink sewage effluent.

Q. And irrespective of any bodies of water, such effluent can be produced?

A. It is scientifically possible to do that, but practically——
417 Q. Have you ever known of its being done?

A. No.

Q. Have you ever seen the effluent that they produced at the sewage disposal system at Saratoga?

A. Yes.

Q. What kind of effluent is that?

A. When I saw it, it was, as I remember it, a reasonably clear liquid; I don't think I have seen it on more than one occasion.

Q. And the condition of that effluent was what, apart from any body of water anywhere, as to whether it was to be discharged into a body of water or not; we are talking of the effluent?

Mr. Riker: When you saw it.

A. I was referring to the clearness of the effluent. I know nothing about the organic matter which may have been present in the effluent, or how much oxygen might be required to oxidize it.

Q. Have you ever seen anybody drink the effluent up there?

A. No, sir.
Q. Have you ever heard of their drinking the effluent?

Mr. Riker: The question is objected to as calling for a hearsay answer.

Commissioner Maher: The objection of counsel for the
418 defendants will be noted.

A. I may have heard it, but I don't recall it at the present time.
Q. What system do they use to produce that effluent?

Mr. Riker: The question is objected to as being immaterial and irrelevant and not cross-examination.
Commissioner Maher: The objection of defendants' counsel will be noted.

A. My recollection of the plan as I saw it is that the sewage was put through a septic tank, and that the effluent from that septic tank went through sand filters, that was some time ago; possibly there may be some different conditions which I haven't seen.
Q. You spoke about the device at the multiple outlets near Robbins Reef that will receive the discharge from the Passaic Valley trunk sewer, what temperature would that sewage effluent register in July, August and September, when it reached the outfall?

Mr. Riker: The question is objected to on the ground that no questions were directed to this witness with reference to the Passaic Valley effluent, and that the question is not cross-examination and is immaterial and irrelevant.
419 Commissioner Maher: The objection of counsel for defendants will be noted.
Mr. O'Sullivan: The question is pressed, for the reason that one of the four last questions put by defendants' counsel to this witness related to the outfall plans of the Passaic Valley Sewerage Commission.

A. I don't know exactly; I can only estimate; it probably wouldn't be very far from seventy degrees.
Q. In the tables that you put in as evidence, you gave water temperatures, are you familiar with the water temperatures of the Upper Bay of New York during the summer months?
A. I probably have taken some, but I don't remember what they are; I should suppose that they might run up to seventy-five or eighty degrees in summer, in the Upper Part, I mean up by New York.
Q. By Robbins Reef?
A. I cannot say exactly.
Q. So that according to your last answer, Mr. Whipple, the sewage would be about ten degrees lower in temperature than the supernatant waters at the outlet?
A. No, I don't think that.
Q. What difference in temperature would there be?

A. I cannot say off hand; it would be a pure, almost guess
420 on my part.

Q. Would you expect the waters of the Bay to be of a higher or lower temperature than the sewage effluent that would be brought to the outfall at Robbins Reef?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. During the summer I should say that the temperature of the sewage would probably be higher than the salt water entering the Bay. There might be——

Q. About how much higher would you make your estimate?

A. I don't wish to make any estimate; I haven't the basis for it.

Q. Is warm water heavier or lighter than water that is five or six degrees lower in temperature?

A. Warm water is lighter than other water five or six degrees lower in temperature, provided that the salinity is the same.

Q. Is fresh water sewage lighter or heavier than brackish water of the same temperature?

A. It is lighter.

Q. With regard to the deportment of sewage discharged into water that has higher specific gravity, how does that discharged matter act?

421 A. That depends a good deal on the rapidity with which outfalling sewage mingles with the water. If it discharges in a large volume, and if the mixing is very fast, then the sewage would tend to rise in the brackish water, being lighter, but if there is a considerable current at the point of discharge, if the sewage is so discharged that mixing takes place quite rapidly, then the tendency for the sewage to rise would be very materially decreased.

Q. Do you know where conditions such as you have described in your answer obtains now, in regard to the discharge of fresh water sewage into either brackish or salt water bodies of water?

A. I know that at the Nut Island outlet in Boston, where there is a considerable discharge of sewage into the salt water of the Harbor, that the effluent pipe being merely turned upwards, so that the opportunity for mixing is not very great, there is a tendency for the sewage to rise towards the surface; but by the time it reaches the surface it has become mixed with a considerable volume of water. At Deer Island there is a multiple outlet, and where less sewage is discharged through each outlet, the mixing appears to be more rapid, and there is less evidence of the sewage at the surface.

422 At Swampscott, where a relatively small amount of sewage is discharged at a considerable depth, it is almost impossible to find the outlet of the sewer by the sewage coming to the top; and that it is a certain extent—almost to the same extent, true of the New Bedford outlet.

Q. What is the population of Swampscott?

A. I don't know; it is small, and the amount of sewage is not over one or two million gallons a day, I suppose.

Q. It is a summer resort, is it not?

A. It is a permanent settlement; the population has somewhat ncreased.

Q. Purely residential sewage, is it not?

A. No, I think there is some manufacturing there; it is more resi-ential than anything else.

Q. How far out do the discharge pipes go before they have their utlet?

A. I am speaking from memory, but as I remember it, about half mile perhaps.

Q. And it is discharged into the open water, the ocean water?

A. Practically that.

Q. What is the salinity of the water there?

A. I don't remember from the analysis but it must be in 23 the vicinity of seventeen or eighteen thousand; that is an estimate, however.

Q. What is the salinity of the water in New York Bay or Upper Bay of New York?

A. It varies more or less in different seasons of the year; in November, 1909, it was at Robbins Reef 16,000 parts per million f chlorine. In May, 1919, the chlorine at that same point was 0,500 at the surface and 12,800 parts per million at a depth of ixty feet.

Q. How do you account for the difference in salinity between the trata of the waters as you have given it?

A. I suppose it is due to the phenomena known as the underrun f the salt water; the salt water being heavier than the fresh, it tends o flow in at the bottom and it is quite common to find the lower ayers saltier than the layers nearer the surface. I have observed hat a good many miles up the river.

Q. Within what range do you find that variation in salinity in he waters of the Upper Bay of New York?

A. The difference in chlorine is sometimes two or three thousand arts per million, and I think there have been particular cases where t is a good deal more than that.

Q. When do you find the lowest percentages of salinity in the vaters of the Upper Bay of New York, what parts of the year?

424 A. When the flow of the Hudson River is large.

Q. During what months?

A. Generally, during the spring months of the year.

Q. When is the salinity about half that of the land water; in other words, when does the amount of salt water about equal the amount of land water in the Upper Bay of New York?

A. That might be true in the summer, it might be true to some extent at other times; it depends largely upon the storm flow of the Hudson.

Q. Have you ever known conditions in the Upper Bay of New York where the air currents, winds, would determine the percentages of salinity in the waters of the Upper Bay of New York?

A. I cannot give specific instances, but in general air currents are

to some extent responsible for the mixing of the waters, vertically, so that with high wind velocities there might be a mixing of the waters from the top and bottom, making the salinities more nearly uniform throughout the depth.

Q. Have you ever known a case of the kind you have just described, Mr. Whipple, in the water of the Upper Bay of New York?

A. Not in New York Harbor; no, sir; I never studied that question in New York Harbor.

425 Q. Have you studied the tidal currents in the Harbor of New York?

A. In a general way only.

Q. How does New York Harbor compare with Boston Harbor; will you state the points of resemblance and the points of difference, from the standpoint of a sanitary engineer who is discussing matters relating to sewage disposal?

A. Boston Harbor is a fairly open harbor; it is bathed by the tidal flow which has a range something less than ten feet, as I remember it. There is a single inlet, a large wide inlet; there are no large streams which enter the harbor; the tendency is for the salt water to penetrate farther into the harbor, I should say. New York Harbor is a harbor which has two inlets for the tide, one at Narrows and one from Long Island Sound. The tidal range is less, being something less than four and one-half feet, as I remember it. The great difference, however, is the fact that the Hudson River, with its very large flow, discharges through the Harbor, through what is commonly called the Harbor; that there is a cross connection from the Upper Harbor, Upper Bay, to Long Island Sound, known as the East River; and there is another cross connection from the East River to the Hudson River, known as the Harlem. That Harbor has a branch known as Newark Bay, which is fed by two

426 large streams, the Passaic River and the Hackensack, and which discharges partly into New York Bay and partly through Arthur Kill around Staten Island, thus making a more complicated situation in so far as tidal flow is concerned and the movements of the water, giving rise to great variations from time to time, in the quality of the water, as to its salinity, and as to the dilution of the sewage. An important difference is the fact that the Hudson River, besides being fresh, is also very turbid at times, thus making the water of the New York Harbor naturally less clear than the water in Boston Harbor. Mention should be made also of the shallow areas between Robbins Reef light and the Jersey shore, and the wide areas of shallow places in Newark Bay, and the fact that in Boston Harbor there are not quite as many shallow places, although there are some.

Q. Expressing the diluting power of the two Harbors in cubic feet per second per thousand of population, how would they compare?

Mr. Riker: The question is objected to as not being cross-examination, and immaterial and irrelevant.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I have not made that computation for Boston Harbor;
427 I cannot tell you what it is, and there I cannot compare the two.

Q. I read from page 148 of the report on Sewage Disposal of Paterson, New Jersey, published in 1906, to which you contributed with Mr. Allan Hazen, and in which it is given as 279 cubic feet per second per thousand population, by the census of 1900, while that in New York Harbor is given at 72 cubic feet per second per thousand of population. Does that refresh your recollection in the matter?

A. No, sir, I don't remember that computation; I don't think I made it.

Q. Do you know who made it?

A. I presume Mr. Hazen, but I don't know.

Q. Have you any reason to doubt it?

Mr. Riker: The question is objected to as being entirely immaterial whether he doubts it or not; he says he doesn't know.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. I have no reason to doubt it or approve it, because I have not made the computation.

Q. What figures did you make in giving the population of New York City, in your direct examination, those of the Federal Census of 1910, on which you would make a computation, or those
428 of the State Census of the State of New York?

A. I took those of the Federal Census only.

Q. And on what rate did you make your computation, what percentage of increase?

A. I assumed the arithmetical method of increase, finding the increment between 1900 and 1910, dividing that increment by the difference in time between the two censuses, which was something less than ten years—not exactly ten years; and then assuming that since 1910 that same increase had occurred yearly. That apparently is the method followed by the City of New York in its Department of Health.

Q. And what did you estimate the increase to have been in the City of New York between 1909 and 1919, from which you made comparisons?

A. I think I called it 134,700 persons per year.

Q. Making an aggregate of 1,347,300 for the ten years, was it not?

A. Yes, sir.

Q. How many manufacturing plants have been erected and in operation in the City of New York since 1909 and up to the present year, 1919?

A. I don't know.

Q. How many do they aggregate approximately?

429 A. I don't know.

Q. Are there over 40,000?

A. I don't know.

Q. In making estimates or calculations as to the disposal of sewage, do you include trade waste under the generic head "sewage"?

A. It depends upon whether the trade waste is discharged into the sewers or not.

Q. Are you regarding everything under the term of "sewage" as matters that are transprted in the sewers?

A. Using the word in a broad sense, yes.

Q. In calculating the sewage discharge of the City of New York, what would your estimate be?

A. I have made no computation, I don't know what it would be; I understand it to be in the vicinity of 120 gallons a day per capita, but that is a figure obtained not from my own computation; I have no knowledge as to its correctness.

Q. In the ten years between 1909 and 1919, in which in your direct testimony you stated that the increase in population was 1,347,300, would that estimate imply an increase in the organic matters discharged into the Hudson River, the East River, and Harlem River and the Upper Bay of New York?

A. Yes, sir.

430 Q. And in the disposal of that organic matter, oxygen would be consumed?

A. Yes, sir.

Q. Whether by direct chemical union with the products of disintegration or by biological agencies, the fact will be that the oxygen would be consumed?

A. Yes, sir.

Q. Will you refer to the exhibits—Defendants' Exhibit 8 and Defendants' Exhibit 9, which purport to give the dissolved oxygen in New York Harbor on November 3, 1909, and on May 3, 1919, referring to the sample taken at Station A on November 3, 1909, I ask you what the percentage of oxygen found on that occasion was?

A. At the surface 62 per cent.

Q. At the same station, on May 3, 1919, what was the oxygen percentage then?

A. 69.6 per cent.

Q. How do you account, Mr. Whipple, for that increase, in view of the fact that organic burdens were increased in the waters from which these samples were taken?

A. I don't undertake to account for it, because the condition of the water was not the same on the two dates with respect to the salinity, and because no two samples taken just like that, ten years apart, can fairly represent the true conditions, the true conditions of the two years. Perhaps that is the substance of my an-

431 swer, that we cannot compare those two particular samples, and from that argue that the conditions are very much better in 1919, than in 1909.

Q. I ask you to account for that improvement, to what factors you attribute that, if it is important?

A. I don't pretend to explain; I don't think it can be explained on the basis of any facts which I have. It is true, however, that

reaeration is a factor. It is true that on this day, May 3, 1919, there was present in the water at that point a large number of microscopic organisms, which tend to oxygenate the water. I don't say that they are doing that, but they were present, and that is their tendency.

Q. That sample of water taken on November 3, 1909 at station A, at the surface, what condition of the tide was that; was it ebb or flood?

A. I think it was on the condition of flood.

Q. Do you feel sure of that?

A. On that day the tide was high at Governor's Island at eleven minutes past twelve according to the nautical almanac. This sample was taken at 10:45 a. m. and presumably the tide was in flood at that hour. That is the only information that I have.

432 Q. The sample taken on May 3, 1919, at Station A, at the surface was also taken at the flood, was it not?

A. Yes, but the difference in time was not quite the same.

Q. What was the difference in time?

A. In 1919, the sample was taken about one and one-half hours before high water at Governor's Island, whereas in 1909, it was taken—Well about the same.

Q. Both samples were taken at flood tide, practically, were they not?

A. Yes, sir, I should say pretty nearly that; just before flood, or just before high water.

Q. When you speak of ebb and flood, do you regard it as a flood tide until it reaches slack water, or do you regard it as a flood tide while it is still coming in?

A. Well, strictly speaking, in most cases we regard the flood tide as including the inflowing current between low water and high water; but in New York, on account of the fact that there are two inlets, the tide,—the current does not turn on the high and low tide points, and therefore the figures which I have given—I mean the statements which I have made refer not so much to the direction of the flow as to the vertical rise and fall of the water.

Q. How does the flood water enter the Upper Bay of New York, on the surface or below the surface.

433 A. The incoming salt water enters the Narrows first at the sides of the channel and at the bottom. Later, the current turns in mid-stream at the surface. There may be an inward current setting in at the bottom at the same time that there is an outward flow of the surface water. That persists for a certain time, the duration of which I don't know, and doubtless varies under different conditions.

Q. What do you understand by that phenomenon of the underrun in the Upper Bay of New York; will you please describe as fully as you may what you understand by the phenomenon of the underrun?

A. Merely the fact that on the incoming tide the salt water enters first at the bottom, and while the surface water may be discharging at the top, it runs under. At first it crosses the upward current and

later on it simply precedes it, so that it results in there being a water or current of greater salinity entering the Harbor in the North River at the bottom than at the surface. I made a study of that phenomenon in 1903, in connection with the work of the Commission on Additional Water Supply at a time when it was thought that the Hudson River might be a possible source of supply for the City of New York, and when the question of the underrun in the pockets,—in the low spots in the river, in the vicinity of West
434 Point and thereabouts appeared to be an important matter.

Q. What depth has the underrun as it enters at slack water or at ebb tide?

A. You mean the thickness of the salt water current at the bottom?

Q. The size of the salt water as it enters?

A. I don't remember. I never studied that with sufficient detail to answer that question. I am simply conversant with the general phenomenon.

Q. What percentage of the water that comes in on the flood has already been in the Harbor and has gone out polluted on some preceding ebb tide?

A. There again I must speak from memory, but I should say, as I recall it, it is something like sixty or seventy or seventy-five per cent; twenty to twenty-five percent of the water which goes out does not return, as I remember it.

Q. I direct your attention, Mr. Whipple, to the report on Sewage Disposal, of Paterson, New Jersey, published in 1906, to which you contributed; I read from page 142, the report by Allan Hazen:

"I found that about seventy-nine per cent of the water that once goes through the Narrows comes back again. The other twenty-one per cent does not come back, but instead twenty-three per cent of the flood tide is made up of new sea water, water that has never
435 been in the Harbor before, and following the same computation at a point on the North River, for which figures were given the percentage, was only one or two less, almost the same thing. (And there is an asterisk calling attention to a foot note just below the point I have read.) The whole volume of the flood is smaller than that of the ebb."

Does that refresh your memory as to the percentage of water that does, and the percentage of water that does not return after going out on the ebb?

A. Yes, sir, and it agrees pretty well with the estimate that I just made of about twenty-five per cent. I think that since then other computations have been made by New York engineers, which agree substantially with Mr. Hazen's estimate.

Q. So that the minimum estimate was seventy-five per cent of the water that comes in on the flood, had already gone out on a preceding ebb, polluted, and returned on the flood?

Mr. Riker: The question is objected to, as the interpolation of the word "polluted" is counsel's and not appearing in the evidence.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. The computation refers simply to the water coming back. The — comes back substantially in the condition, perhaps, in which it went out. It may come back substantially in the condition in which it went out, or it may have been changed by its brief
436 stay in the lower Harbor.

Q. Have you given any thought to the peculiar ocean tidal currents between Bradley Beach and Long Beach, outside the Harbor's mouth?

Mr. Riker: The question is objected to as not cross-examination, and immaterial and irrelevant.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. No, sir, I don't recognize the localities by the names you give.

Q. Do you know of any peculiar tidal conditions outside the Harbor's mouth that will cause ninety per cent of the ebb tide to return on the flood tide into the Upper Bay of New York?

A. No, except these conditions which might result temporarily from on-shore winds.

Q. Do you state something that you know or that you are merely reasoning out now, Mr. Whipple?

A. My answer was based on my general knowledge of the relations between on-shore winds and the elevations of the water in the Harbor at those times, this studying having been made in 1903, in connection with the work for the commission on additional water supply.

Q. My question was directed to the tidal currents in the ocean outside of the Harbor's mouth that would beget a condition
437 that would return ninety per cent of the ebb on the incoming flood tide.

A. I don't know about those conditions if they exist.

Q. Have you ever heard of an estimate as high as ninety per cent of the ebb waters returning on the flood into the Upper Bay of New York?

A. I don't recall it, no, sir.

Q. Do you know General Robert who was president of the Harbor Line Board for many years?

A. No, sir.

Q. You haven't read his testimony?

A. I have not.

Q. You did read the testimony in this case, did you not?

A. Not the whole of it, no, sir; a very small part of it.

Q. You wrote an article on it, did you not, last December?

A. I made a general review of it, yes, sir.

Q. You don't recall General Robert's testimony?

A. I don't recall that. My review related more to the exhibits in the case than to the testimony.

Q. Did you read the testimony of Professor William T. Sedgwick of the Massachusetts Institute of Technology?

A. I did in part, yes, sir.

Q. Which did you read, his cross-examination or his direct examination?

438 A. I don't remember now.

Q. Did you read the testimony of Professor William P. Mason of the Rensselaer Polytechnic Institute?

A. I may have done so, I don't remember.

Q. Did you read the testimony of Professor Olin H. Landreth of Union University?

Mr. Riker: The question is objected to on the ground that it is not cross-examination, and as immaterial and irrelevant.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. I don't remember definitely; I have looked over all the testimony in a general way, but have not read all of it carefully.

Q. Do you know Professor Landreth?

A. Very well.

Q. Do you know whether or not he had been for sixteen years working on this problem of the Upper Bay of New York and its power to assimilate and digest sewage and receive this burden that it is being contemplated to put upon it by the Passaic Valley Sewerage Commission?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. I know that he has been studying the problem for a
439 considerable time, I don't know how carefully.

Q. Did you read his testimony in part?

A. I don't recall it.

Q. Did you read the testimony of Professor Earl B. Phelps?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. I think I read most of Professor Phelps' testimony.

Q. Do you recall that he did special work covering several months for the Board of Estimate and Apportionment on these oxygen determinations to which you have testified?

A. Yes, sir, I remember those.

Q. Did you read the testimony of Professor Edward Ellery a chemist and professor of chemistry in Union University?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. I don't recall it.

Q. You just stated that you gave considerable attention to the exhibits; did you study Professor Ellery's Exhibit on this topic of reaeration in pure fresh water, pure salt water, and polluted salt and polluted fresh waters?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for the defendants will be noted.

440 A. I don't remember that by his name.

Q. Did you read the testimony of Harrison P. Eddy, consulting engineer of Boston?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I think I read a part of it.

Q. Did you read the testimony he gave on the Moon Island, the Nut Island and the Deer Island outlets and the color investigations and tests that he made there as to the field of sewage from submerged outlets?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I think I remember reading part of that.

Q. Did you read the testimony of Mr. Emil Knichling, Consulting Engineer, who had made a continuous study for some years of this very topic that is involved in our questions and your answers now?

Mr. Riker: Same objection, and the further objection that the statement of fact of counsel is immaterial.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I remember reading a part of his testimony.

441 Q. Did you read his testimony on Plankton—those organisms that you say contribute oxygen to these waters, upon whose presence you have undertaken to account for these figures in oxygen in the waters that are included here in this table of oxygen percentages which you have put in evidence?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I remember reading a part of his testimony.

Q. Did you read the testimony of Mr. John W. Alvord, Sanitary and Hydraulic Engineer of Chicago, given in this case?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I don't recall that I did.

Q. Did you — testimony of Mr. Desmond Fitzgerald, consulting and hydraulic engineer of Boston?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I remember reading a part of that.

Q. Do you know Mr. Fitzgerald?

A. Very well; I used to work for him.

Q. He is an eminent engineer, is he not?

442 Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. He is an eminent water supply engineer.

Q. Did you read the testimony of Professor Charles E. A. Winslow, Consulting Engineer and Biological Chemist and Engineer?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I remember looking that over, yes, sir; I recall looking over his testimony in a general way.

Q. Did you read the testimony given in this case by Mr. Robert Spurr Weston, Consulting Engineer of Boston?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. I remember looking that over.

Q. Do you recall reading the testimony of Mr. Theodore Horton, the Chief Engineer of the State Department of Health of the State of New York, who had been engaged on this Passaic Valley Sewage Project from 1901 to 1906?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

Mr. Riker: And the further objection that counsel is in-
443 terpolating his own comments on the effect of the testimony of these witnesses.

Commissioner Maher: The further objection of counsel for defendants will be noted.

A. I remember looking that over.

Q. Did you read the testimony of Dr. George A. Soper, President of the Metropolitan Sewerage Commission?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. I remember reading part of that.

Q. In looking through the exhibits in this case, Mr. Whipple, do you recall the many hundreds of oxygen determinations that were made in these Harbor waters by the Metropolitan Sewerage Commission at almost all depths and on various areas all over these waters?

Mr. Riker: The question is objected to for the reasons given in the last objection, and for the further reason that counsel is interpolating in the record his own conclusions from the testimony, and not quoting from it.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I remember examining a great many of those dissolved oxygen records taken in many different places and stages of the tide,
444 but on a comparatively small number of days.

Q. Were you given full access to the oxygen determinations made by the Board of Estimate and Apportionment's Sanitary Engineers, who are employed by that department of the City of New York and who recently showed to you the oxygen determinations they made between the years 1914 and 1918?

Mr. Riker: The question is objected to as not being cross-examination, and immaterial and irrelevant, nothing having been said about those records.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. Yes, sir, I was given access to dissolved oxygen records which I supposed were in full, but I have no knowledge as to their fullness; I have no knowledge as to their completeness, but I assume I was given a complete statement.

Q. Was anything withheld from you?

A. No, sir, not so far as I know; nothing that I asked for was withheld.

Q. Did you read the testimony of Mr. H. De B. Parsons, a member of the Metropolitan Sewerage Commission, on the tidal phenomena in the New York Harbor waters?

Mr. Riker: Same objection.

445 Commissioner Maher: The objection of counsel for defendants will be noted.

A. I don't remember about his testimony, but I remember reading his testimony in the American Society of Civil Engineers.

Q. Do you recall how much water he estimated returns on the flood that had left the Harbor on a preceding ebb, and which he determined after some years of salinometer and other work on the Harbor currents and waters?

A. I had in mind about seventy-five per cent, but I don't remember exactly.

Q. Did you read the testimony of Mr. James H. Fuertes, Sanitary Engineer and member of the Metropolitan Sewerage Commission

on the fact that Sewage will maintain its identify for many miles, on which he gave illustrated examples from the Monongahela and other rivers as well as our tidal waters?

Mr. Riker: The question is objected to for the same reason, and for the further reason that counsel is giving his own interpretation of the testimony.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I don't remember reading Mr. Fuertes' testimony.

Q. Do you remember reading the testimony of Mr. Daniel D. Johnson, who was Chief Engineer of the Department of
446 Water Supply and who was for many years the chief analytist in the Mt. Prospect Laboratories, relative to the oxygen content of our waters and their re-aeration?

Mr. Riker: The question is objected to on the ground that it is not cross-examination, and immaterial and irrelevant and for the reason that the testimony of this witness is directed to the comparison of his examinations made on definite dates, which have nothing to do with the examinations made by the witness referred to by counsel.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I remember reading part of his testimony.

Q. Do you recall reading the testimony of Professor Floyd J. Metzger, Professor of Chemistry, of Columbia University on these oxygen determinations of the Metropolitan Sewerage Commission?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I don't remember of reading that.

Q. Mr. Whipple, taking that second sample, marked A, at a depth of twenty feet and comparing the dissolved oxygen in Defendants' Exhibit 8 and in Defendants' Exhibit 9, of this date, what did
447 you find the percentage of oxygen to be on November 3, 1909?

A. Sixty-three per cent.

Q. And how much on May 3, 1919, at the same station?

A. 67.7 per cent.

Q. How do you account for that increase?

A. I don't pretend to account for it; I don't know how to account for it.

Q. Taking sample B of November 3, 1909, at the surface, you found 64 per cent on November 3, 1909; why didn't you make a similar determination for that same station on May 3, 1919?

A. That sample was lost for some reason—I don't remember now why—something happened to the determination.

Q. Taking sample C at the surface, November 3, 1909, what did you find the oxygen per cent to be?

A. 62 per cent.

Q. What did you find it at the same station on May 3, 1919?
A. That was 73.6 per cent.
Q. An increase of how much?
A. 11.6 per cent.
Q. How do you account for that, Mr. Whipple?
A. I don't pretend to account for it.
Q. Taking the sample at station C sixty-three feet below the surface, on November 3, 1909, you made no determination of the
448 oxygen percentage at that station, did you, at that depth?
A. The figure doesn't seem to be carried out. I don't know why—oh, I see; a determination was made, but for some reason the temperature was accidentally omitted, and therefore it was impossible to compute the percentage of saturation.
Q. At what temperature will unpolluted fresh water hold its largest oxygen saturation percentage?
A. At zero degree, centigrade.
Q. How does the capacity to hold oxygen in solution in fresh unpolluted water diminish with the rising temperature; can you give me the ratio about?
A. I can give you the figures by referring to a table but I don't remember it.
Q. I do not want all the figures, Mr. Whipple, but what I do want is, the higher the temperature of fresh unpolluted water is raised, the less oxygen it can hold in saturation, until at the boiling point it is unable to hold any?
A. Correct.
Q. What I wish to know, is this, at what ratio does it lose the power of holding oxygen in saturation with each degree, approximately?
A. At something over thirty degrees, centigrade, it will hold only half as much as it will at the zero degree, centigrade.
449 Q. The thirty degrees, centigrade, would be what number of degrees, Fahrenheit, about?
A. About eighty-six.
Q. And what would the highest temperature of New York Harbor waters be during the warm months, the temperature of the water?
A. I should think in the vicinity of seventy or eighty degrees at the surface; probably not as much as that in incoming water.
Q. What is the difference in the capacity for fresh unpolluted water and for clear pure sea-water to hold oxygen in saturation?
A. At zero degree, the salt will hold about eighty per cent of the fresh waters.
Q. Is that eighty degrees, centigrade or Fahrenheit?

Mr. Riker: Eighty per cent he said.

A. Eighty per cent, and the percentage will be not greatly different at high temperatures.
Q. So that temperatures being equal, there would be a difference of thirty per cent in the capacity of fresh water and salt water to hold oxygen in saturation, in favor of fresh water?
A. Yes, in corresponding temperature.

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Q. How do fresh water, salt water and brackish water, un-
450 polluted, compare as to their capacities to hold oxygen in saturation?

A. The brackish water would be intermediate between fresh water and salt water, and the exact amount would depend upon the brackishness of the water.

Q. During the warmer months how do you regard the percentages of fresh and salt water in the Upper Bay of New York?

Mr. Riker: The question is objected to as being too indefinite.

Commissioner Maher: The objection of counsel for defendants will be noted.

Q. —as to the salinity?

A. It depends upon the flow of the Hudson River at that time; it varies in different years.

Q. Taking an average for some years that you are probably aware of, what would you place it at?

A. Speaking very generally, I should say from 9,000 to 12,000 per million of chlorine, but that is a mere estimate.

Q. During the months of July, August and September aren't the percentages of land water and sea-water about equal in the Upper Bay of New York, approximately?

A. That would be approximately true, from the figure I have just given.

Q. Do fresh water micro-organisms survive in salt water?

Mr. Riker: The question is objected to on the ground that
451 it is not cross-examination, and immaterial and irrelevant.

Commissioner Maher: The objection of counsel for defendant will be noted.

A. Some do and some don't.

Q. As to percentages, what percentages would survive?

A. I have no knowledge.

Q. Isn't it very small?

Mr. Riker: The question is objected to on the same ground as the last question.

Commissioner Maher: The objection of counsel for defendant will be noted.

A. I have no definite knowledge as to percentages; it is true that a good many fresh water organisms do not live long after entering salt water. I have often found many fresh water organisms in Harbor waters.

Q. How long after the admixture of the salt and fresh water?

A. I have never kept any record of it.

Q. Are you familiar with the studies on this topic of Wilhelmi and Kolkwitz?

A. I think I remember those names; I don't remember the studies that you speak of in particular.

Q. With regard to organisms that disintegrate organic matter in salt water, will they survive in fresh water?

Mr. Riker: Objected to on the ground that it is not cross
452 examination; immaterial and irrelevant, and for the reason that it appears that the subject matter of this inquiry is the Bay of New York, which is brackish water.

Commissioner Maher: The objection of counsel for the defendants will be noted.

Mr. O'Sullivan: The objection is pressed for the reason that this witness in his direct testimony dealt at considerable length with the micro-organisms that in part account for the oxygen improvement in its saturation in the Upper Bay of New York, and of the Hudson and East Rivers, which he attributed to these very micro-organisms.

—. I think some of them will and some of them will not, and I might say that there are a great many organisms found most in salt and fresh, some belonging to the vegetable kingdom and some to the animal kingdom, and to different classes in each. I made a considerable study of this matter in connection with some of the harbods of New England some years ago, and my answers are based on my own observations.

Q. Is it not a fact, Mr. Whipple, that the smallest percentages of organisms survive in brackish water as compared with the percentage of organisms found in fresh water and the percentage of micro-organisms found in salt water?

453 A. I am unable to answer that question.

Q. I understand in your direct examination that you collected some samples and examined for these micro-organisms and undertook to account for the increase in the oxygen saturation at the stations that you secured samples from, by these organisms?

Mr. Riker: I don't understand there is any question.

Q. Is that a fact?

A. The fact is that I examined some of the samples of water to find what microscopic organisms were present. I had not given that as the main reason why—to account for the large amount of dissolved oxygen in 1919, as compared with 1909; I merely suggest that as a possible explanation.

Q. Is it not a fact, Mr. Whipple, that only one large group of these organisms are capable of liberating oxygen, and that group is the chlorophyceæ?

A. No, sir, that is not the fact because there are other organisms than the chlorophyceæ which contain chlorophyll. It is a fact that this phenomena is confined to the chlorophyll bearing organism, but there is more than one class of it.

Q. Chlorophyll is the green coloring matter of plant life, is it not?

454 A. Yes, sir.

Q. And that has the power, in the presence of sunlight, of disintegrating carbon dioxide and liberating the oxygen?

A. That is correct.

Q. And carbon dioxide is a gas resulting in waters from the disintegration of organic matter where it is disintegrated under aerobic conditions; is that a fact?

A. Carbonic acid in water comes partly from the air because the atmosphere contains carbonic acid, but it may also come from the decomposition of organic matter by bacteria, not necessarily, however, aerobic bacteria.

Q. Do you make a distinction, Mr. Whipple, between the terms decomposition, putrefaction and fermentation, when applied to bacterial activities in disintegrating organic matter, and if so, will you state what the distinction is?

A. There are differences in the uses of those words, but they are not very generally adopted, and different people do not always use them in the same way. Personally, I used the word "decomposition" in a rather general sense, covering bacterial—what may be called the bacterial destruction of organic matter. But the term "putrefaction" would not apply unless the decomposition had preceded to such a point that all oxygen had disappeared, and that the bacteria, in their search for oxygen, seized upon the oxygen of the
455 organic matter. This putrefaction is usually accompanied by foul smelling compounds and gases. The term "fermentation" is most often used in connection with the breaking down of carbonaceous matter, and yeasts, as well as bacteria, often play an important part; whereas the term "putrefaction" is more often used in connection with the breaking down of nitrogeneous organic matter.

Q. When you use the term "nitrogeneous," do you confine that to protein compounds?

Mr. Riker: Objected to on the ground of not being cross-examination, and immaterial and irrelevant.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. Not necessarily, but usually.

Q. Can carbonaceous matters undergo putrefactive changes?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. Yes, in a general way, but in the more commonly accepted use of the term "putrefaction," I should say not.

Q. When sewage is septic, what form of disintegration does the hydrocarbons or carbonaceous matter undergo?

A. The putrefaction.

456 Q. What distinction do you attach to the terms "fresh," "stale" and "septic" as applied to the condition of a given sewage?

Mr. Riker: The question is objected to as not being cross examination.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. In fresh sewage the decomposition is usually taking place while there is still dissolved oxygen in the sewage. That represents

decomposition in the fresh sewage in the condition of staleness, the oxygen is almost or quite disappeared. Whereas, in the condition of septicity, the oxygen has entirely disappeared, and the bacteria are getting their oxygen supply from the organ compounds themselves, thus breaking them down.

Q. How long does it take sewage to become septic during the months of July, August and September under ordinary conditions?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. It is impossible to give a definite answer to that, because it depends on how sewage is kept—whether it is quiet or whether it is moving; whether it has an opportunity for re-aeration or
457 not; whether sludge is allowed to accumulate in the sewage or not.

Q. If sewage is transported with a very slight slope or grade, in the transporting interceptor especially, and is confined in a trunk sewer for twelve, fourteen or sixteen hours, in warm weather, is that a sufficient time and are the conditions favorable to septicity?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. There again, I cannot answer without presupposing the strength of the sewage, but taking the sewage by and large as we get it, I should say that amount of time in warm weather would be sufficient for the sewage to become septic; but one cannot answer a question like this definitely, without knowing the conditions.

Q. In what condition does the sewage reach the outfall at Moon Island in Boston Harbor as to its septicity?

A. I don't recall any analysis which would enable me to answer that question, but my impression is that under summer conditions there would be times when the sewage would reach that point in a septic condition.

Q. What is the age of the sewage when it reaches the sewage outfall at Moon Island in Boston Harbor?

A. That I don't know, because I don't know the velocity
458 of the sewage in the sewers. I know that some of that sewage comes from a point some twenty-odd miles away from the point of discharge.

Q. Does it take any considerable length of time for septic sewage to infect fresh sewage and reduce it to a condition of septicity?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted

A. I don't think that can be measured in terms of time.

Q. Have you ever undertaken any laboratory experiments to determine that fact, Mr. Whipple?

A. No, sir.

Q. Have you ever made observations or investigations at sewage disposal systems that had detention tanks for the determination of that fact?

A. Not the time factor. I know there is a question of the "seeding" of tanks in which septic action has occurred; that, however, is a different question from the question of the time required.

Q. Approximately, is it a short or long period of time?

A. I should say it was—I am unable to give any answer to that.

Q. What gases are given off under conditions where
459 anaerobic decomposition changes disintegrate organic matter?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. Carbonic acid, marsh gas, hydrogen and some other gases in very small quantity.

Q. What gases evolve from anaerobic putrefaction of organic matter?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. The same gases, with some others in smaller proportions.

Q. Is hydrogen sulphide a product of anaerobic decomposition changes?

A. Very often, yes, sir; more so than in the case of aerobic decomposition.

Q. Is methane?

A. Yes, sir; I question that. That is the same as marsh-gas.

Q. What organisms did you determine were present in the samples that you examined and which you took in the month of May, 1919, from New York Harbor waters?

A. There were a good many diatoms present, the particular species of which I did not identify. The principal organism was one which is probably melosira. There were also some green
460 chlorophyllaceous algæ.

Q. Did you determine what species these latter were?

A. I did not.

Q. Do the diatoms add oxygen to water?

A. Yes, sir; often a great deal.

Q. What other organisms beside the two groups which you have mentioned?

A. I don't recall at this time just what species were found, the most important ones—by far the most important one was the one which I have said was probably melosira.

Q. At what depth did you secure those organisms?

A. This was the sample collected at the surface or a short distance below.

Q. Will you describe the turbidity of the waters during your tour

of inspection? Is sunlight not the essential to the functional activity of these micro-organisms in liberating oxygen?

A. Yes, sir.

Q. How far would sunlight penetrate in the Hudson as you saw it on May 2nd or 3rd?

A. Only a few feet with sufficient intensity to influence the growth or activity of these organisms.

Q. You made a special study on limnology, did you not?

A. I have, yes, sir.

461 Q. How do you determine that sunlight would penetrate about two feet in the turbid condition which you found the Hudson River, for instance?

Mr. Riker: The question is objected to on the ground that the witness didn't state that it would penetrate two feet.

Commissioner Maher: The objection of counsel for the defendants will be noted.

A. That was a mere estimate on my part, based on my past experience.

Q. What was the condition of sunlight at the time you made the observations?

A. The sun was shining.

Q. You took that question into consideration, the intensity of the light, in making the estimate on its penetration, did you not?

A. I don't quite see what that question means, Dr. O'Sullivan.

Mr. O'Sullivan: Strike out the question.

Q. In making an estimate in relation to the functional activity of micro-organisms that are capable of liberating oxygen in water, with the aid of sunlight, is it not a necessary factor to take into consideration the intensity of the light and the depth to which it penetrates?

462 A. Yes, sir.

Q. The turbidity that you found, I understood in your direct examination that you estimated by a given recognized standard?

A. Yes.

Q. Was that a high or moderate degree of turbidity?

A. I cannot answer that without assuming some basis of comparison. It would be high for a drinking water; it would be low for sewage. It would be somewhat above the ordinary turbidity of the water of the Hudson River above New York.

Q. The Hudson River I understood commingled with the waters of the Upper Bay of New York and gave turbidity to that body of water, did it not?

A. It does.

Q. Does that turbidity act as a screen or as an absorbing agent of the light which would aid these micro-organisms in liberating oxygen?

A. To a certain extent it does act as a screen to prevent the penetration of light into the water; possibly also as an absorbing agent.

At all events, turbidity does prevent sunlight from penetrating water.

Q. At the time that you made these observations, did you take the temperature of the water?

A. I did.

463 Q. What was the temperature at the time that you observed this turbidity?

A. At station B it was 10.9 degrees, centigrade.

Q. How does the temperature of water affect the penetration of the light rays of the sun?

A. I don't know from experiment; I don't think it affects it very greatly.

Q. As I understand your testimony, Mr. Whipple, you found considerable turbidity, you found brackish water, and what other conditions were necessary to show that these waters were in a condition in which it would be difficult to digest a large volume of organic matter?

A. I should hardly say that; I should not say that.

Q. Were the conditions that you found favorable or unfavorable for the digestion of organic matter?

A. Reasonably favorable, chiefly because of the considerable amount of oxygen present.

Adjourned to Friday, June 13th, 1919, at 10.30 a. m.

464 United States Supreme Court.

THE PEOPLE OF THE STATE OF NEW YORK, Complainants,

vs.

THE STATE OF NEW JERSEY and PASSAIC VALLEY SEWERAGE COMMISSIONERS, Defendants.

Continuation of Testimony Taken in the Above-entitled Cause Before James D. Maher, Commissioner Appointed by the Supreme Court of the United States, at the Office of Messrs. Riker & Riker, 164 Market Street, Newark, New Jersey, on Friday, June 13th, 1919, at 10.30 a. m.

Present: Counsel as before stated.

GEORGE C. WHIPPLE resumes the stand for

Further cross-examination.

By Mr. O'Sullivan:

Q. Mr. Whipple, when were your services retained for the investigations which you have testified to in regard to this suit?

A. I think it was the latter part of April sometime, I don't remember exactly.

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Q. Were you shown the order of the Supreme Court of the United States, dated March 10, 1919?

465 A. Yes, sir.

Q. Was any special function allotted to you, or did you choose to perform any special line of investigation as to the parts of the order which you read?

A. I was asked to consider the matter which came up under number three of the order.

Q. That was with regard to present degree of pollution of the waters of New York Harbor?

A. Yes, sir.

Q. When did you look up your files for the oxygen determinations that you testified you made in 1909, I think it was November 3?

A. Just before I repeated the work in 1919; just prior to May 3, 1919.

Q. Did you select the stations that you secured samples from, as indicated in Defendants' Exhibit 8, May 3, 1919?

A. I did.

Q. What was your purpose in selecting those particular stations for the determinations you intended to make in 1919?

A. Merely that they might be the same as the stations covered by the analysis which had previously been made, November 3, 1909.

Q. And for the purpose of comparison with the results?

A. For the purpose of comparison of the two years.

466 Q. Were the water samples that you took on each of those occasions, November 3, 1909, and May 3, 1919, tested on the boat?

A. In part, yes, sir; that is, the analyses were begun on the boat.

Q. What particular determinations did you make in the analysis the samples were subjected to on the boat?

A. Color, turbidity, and the temperature, the beginning of the dissolved oxygen test, but not the chlorine test.

Q. Then the only determination that was made other than those made on the boat was with respect to the chlorine?

A. Yes, sir, that was made in the laboratory.

Q. Will you describe the Winkler method as you used it in making the oxygen determinations on the boat?

A. The samples having been collected, there was first added to the water two cubic centimeters of manganate sulphate and the same quantity of a solution of caustic soda and potassium iodine. That was allowed to stand for a short time and then there was added to it about two cubic centimeters of concentrated hydrochloric acid; that was all that was done to the sample on the boat. The samples were then carried to my office and the test finished.

467 Q. Were the color, odor and turbidity observations and determinations that you made on the boat, made either before or after making the oxygen determinations, and were the same samples used for these various determinations?

A. The turbidity of the water was determined in the Harbor itself, by lowering the turbidity rod in the water. The color was de-

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termined on the boat by a portion of the same sample of which the dissolved oxygen test was made.

Q. Were these determinations for color, odor, turbidity, salinity and oxygen all made on samples taken at the same flood tide in each one of those exhibits—Defendants' Exhibit 8 and Defendants' Exhibit 9?

A. I don't quite understand what you mean by the same flood tide. The various determinations of any one sample were all made at practically the same time.

Q. The dates given in the exhibits, for instance 1919, May 3, were all these samples taken on that same flood tide, samples from A to Q?

A. They were all taken at the hour specified; some of them were taken before high tide occurred at Governor's Island; others were taken after the hour of high tide.

Q. But they were taken on the flood tide?

A. I don't remember whether the sample taken at three o'clock, for example, was taken on the current going in or out but it was taken about three and one-half hours after high tide at Governor's Island; I could say probably on the ebb tide.

468 Q. What is the average period of time for slack water in the Upper Bay of New York?

A. As far as I know, it is an extremely short period, but I am unable to say definitely, because it doubtless varies somewhat in different places.

Q. In the Upper Bay of New York?

A. I think so; my idea is that when the tide turns, it turns very quickly.

Q. Within what period of time approximately?

A. Within a period measured by minutes.

Q. Who accompanied you on May 3, 1919, when you secured these samples and made these determinations on the boat as you testified to?

A. Mr. Gordon M. Fair, and Mr. Savitz of the office of the Passaic Valley Sewerage Commission.

Q. And I understood you to testify that you used a motor launch for the purposes?

A. A motor boat called the Gasseon.

Q. In describing the oily sleek that you found between Robbins Reef and which extended, I understood you to say, to Constable Hook, did you make any effort to determine where that greasy sleek came from?

A. No, sir, except to notice that it was most conspicuous in the vicinity of the oil works, and that it was evidently a mineral

469 oil, as it had the irridescent colors of mineral oil.

Q. What about the oily scum which you described you found in the East River?

A. That appeared to be a mineral oil, as it had the irridescent appearance or *had the irridescent appearance* characteristic of mineral oil.

Q. Did you estimate that it came from the same source?

A. My idea after seeing the conditions in the Gowanus Canal and

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on being told that water was pumped from the Gowanus Canal at intervals into the Buttermilk Channel, was that most of the oily sleeks in Buttermilk Channel and in the vicinity of the East River, most likely came from the Gowanus Canal, and from the gas works located there, in particular.

Q. I understood you to say on your direct examination yesterday, Mr. Whipple, that the turbidity had one advantage in that it obscured the sewage pollution; am I right in my memory of your testimony?

A. Yes, sir.

Q. You consider it an advantage to hide the evidences of pollution?

A. I think that the more inconspicuous way in which sewage can be disposed of, the better.

Q. Do you recommend hiding sewage as a mode of dis-
470 posal of it?

A. Not as a disposal, certainly not.

Q. You used the term "disposal" now; I am asking you if you consider it an advantage to hide evidences of pollution?

A. Yes, if there is no corresponding disadvantage.

Q. In the turbidity that you found in the Hudson River, I understood you to ascribe it to some alluvial or other matter and not to sewage pollution?

A. My general knowledge of the turbidity of the Hudson River is that it is alluvial mineral matter washed from the surface of the ground.

Q. And the turbidity at the Battery you ascribe to sewage pollution, is that correct?

A. I think that at the Battery near the shore the turbidity was due in the first instance to the alluvial matter in suspension in the Hudson River, but also to some sewage discharge along the shores.

Q. How do you distinguish between turbidity due to alluvial or other causes as from washing of earthy substances into water courses, and the turbidity that is due directly to sewage pollution?

A. That could be done to some extent by laboratory studies, biochemical analysis. Those familiar with turbidity due to silt and turbidity due to soapy matters and so-forth of sewage, can
471 make a fair estimate of the difference between them in a stream.

Q. And these determinations that you have just described would be made entirely by the eye?

A. What I referred to is merely the appearance of the water as I saw it as I looked down upon it.

Q. And when you made the estimate that the turbidity at the Battery was due to sewage pollution, were you aware of the fact that there were sewers discharging in that vicinity?

Mr. Riker: The question is objected to on the ground that the witness said that the main source of the turbidity was the alluvial matter; that there was some evidences of sewage addition, and he did not say that it was due to sewage pollution.

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Commissioner Maher: The objection of counsel for defendants will be noted.

A. I am aware that there are sewers discharging in that vicinity, but I did not make the estimate as you stated.

Q. I ask you if you took it into consideration, Mr. Whipple?

A. I did.

Q. And that influenced your determination to some extent that the turbidity was in part due to sewage pollution?

A. Certainly.

Q. In the first part of your direct testimony yesterday, as I remember it, you stated that the micro-organisms added to
472 the turbidity, is that correct?

A. That is correct.

Q. What color was imparted by these micro-organisms, that occasioned that turbidity?

A. They had a greenish brown color as seen under the microscope.

Q. When they were in bulk in the water what general color did they impart to that part of the water where you found them?

Mr. Riker: The question is objected to on the ground that it does not appear by the evidence that they were in bulk.

Commissioner Maher: The objection of counsel for the defendants will be noted.

Q. It is difficult for me to separate the effect of the turbidity produced by the organisms and that produced by the silty material present, but my general thought is that they would tend to increase the greenish brownish character of the color.

Q. Did you apply any tests for that turbidity other than the one that you have testified to already?

A. No, sir.

Q. In going through the Harlem River did you secure any samples of the water from that river?

A. On May 3, 1919, we did not. It was May 2nd, we
473 went through the Harlem River.

Q. You found the river turbid?

A. Yes, sir.

Q. And you found it more turbid than the Hudson River?

A. It appeared to be so to the eye, but no tests were made that day.

Q. Did you attribute any of the turbidity to the waters from the Harlem River that had come into the Harlem River?

A. Yes, sir.

Q. And yet it was more turbid than the Hudson River?

A. It appeared to be so to the eye.

Q. To what did you ascribe the excess of turbidity in that case?

A. I made no distinct attempt to account for it, but my general impression was that it might have been due to sewage pollution entering the Harlem.

Q. If I recall your testimony correctly, Mr. Whipple, you testified

yesterday that you found the East River in May of 1919 in better condition than you found it in 1909; is that correct?

A. Yes, sir, but with respect to its general appearance and the odor from the water.

Q. Was the odor more distinct or less distinct than it was ten years previous?

474 A. There was practically no odor noticed in the East River on May 2, 1919, except very close to the shores; whereas, in November, 1907, when I made the previous inspection—I don't know whether I have the date right in 1907—there was a very decided odor of oil observed, sailing over the river. That previous date was May 28, 1907.

Q. So that the East River had considerably improved in the ten years between 1909 and 1919?

A. With respect to the discharge of oil and as shown on those two dates.

Q. From your observations in general, either the oxygen determinations or other determinations that you may have made, do you say now that the East River is in better condition as far as sewage pollution is concerned in this year of 1919 than it was in the year 1909?

A. From the standpoint of the appearance of the water, I should say that there was less oily matter now than in 1907, but that there was rather more litter on the water; that on the dates mentioned the amount of oxygen present was not greatly different during the two years; there were minor differences in different samples, but on the whole the difference was not much. That statement is limited to the dates in question.

Q. And to the tides on which the samples were taken?

A. It is limited to all the conditions under which the sam-

475 ples were taken, including the tides.

Q. In placing the oxygen factor of safety at twenty per cent or less, what general factors do you take into consideration in making that estimate and setting that standard?

A. I do not set twenty as a definite standard; I am unable to establish any particular figure which is satisfactory to me as a scientific man, but I believe that as long as any oxygen at all is present no serious conditions of putrefaction will arise, but it is necessary in the administration of works to have some factor of safety, because there will always be differences in different parts of the Harbor; there will be differences in two streams of water relatively near together; there will be differences in point of time, so that it is necessary to place the working standard somewhat higher than what would be regarded as the allowable minimum. That is to say, in order that the water should always be kept above an allowable minimum of saturation, it is necessary to have a working standard higher than that, and my judgment is that if the sewage is discharged into the Harbor of New York in what might be called a proper manner, a figure of twenty might be regarded as a reasonable working standard.

Q. In investigating whether or not that standard exceeded the

twenty per cent oxygen saturation or less, what part of the
476 Harbor, or rather what part of the Upper Bay of New York, would you select to make your oxygen determinations, in order to see whether or not that standard obtained?

A. I have in mind applying that standard to what may be called the main body of the water in the Harbor.

Q. If you found the oxygen content in samples of water taken on both tides in the Upper Bay of New York averaged twenty per cent or less, and toward the shores that it was ten per cent less of the oxygen saturation, would you deem that condition satisfactory?

A. The condition might be satisfactory at that particular time; I think it would be; but I would not regard it as satisfactory from an administration standpoint; that is, I believe it would approach too nearly to the limit.

Q. Would you expect a nuisance to exist in the Harbor waters of the Upper Bay of New York under the conditions that I have just implied in my preceding question?

A. Not in those places where the dissolved oxygen was present in the amounts which you stated.

Q. Have you ever made any oxygen determinations at any point in the Passaic River, in Newark Bay or in the Kill von Kull?

Mr. Riker: The question is objected to as not being cross-examination.

477 Commissioner Maher: The objection of counsel for defendants will be noted.

A. I have.

Q. Where, sir?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. On November 3, 1909, I collected a sample at Station M in the Kill von Kull opposite the copper works, in the center of the channel.

Q. What determination in the oxygen content did you make in that particular sample?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. The sample collected at the surface at that point contained 68 per cent of saturation of dissolved oxygen; the sample collected forty feet below the surface gave 64.5 per cent. I have also collected samples in the Passaic River below the City of Paterson, and between Paterson and Newark, but I haven't those data with me.

Q. In answer to a question put to you yesterday, I understood you to say that you read the testimony of Professor Earl B. Phelps.

478 A. I read it somewhat hastily.

Q. Do you recall his making an oxygen determination in the Passaic River in the vicinity of Newark and finding an oxygen

content of 38 per cent of oxygen saturation, at the time when there was gross nuisance in the river?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I think I remember that.

Q. How do you explain the fact that 38 per cent of oxygen content in waters is consistent with a general odor nuisance at the same time, and in view of the fact that you have a factor of safety as twenty per cent of oxygen saturation or less?

Mr. Riker: The question is objected to because it assumes this witness will have to accept the conclusion of Mr. Phelps.

Commissioner Maher: The objection of counsel for defendants will be noted.

Mr. O'Sullivan: The question is pressed for the reason that it is not a conclusion; it is a fact actually determined by direct chemical experimental work.

479 Mr. Riker: The same objection is urged on the ground that the fact of whether or not there is an odor depends entirely upon the testimony of Mr. Phelps, and is not the opinion of this witness.

Commissioner Maher: The further objection of counsel for defendants will be noted.

A. I cannot explain the fact without knowing what the conditions were at the time when the observation was made, because I do not know that the nuisance referred to had anything to do with the fact that the oxygen was thirty-eight per cent saturation.

Q. In your experience as a sanitary engineer, Mr. Whipple, are these two facts consistent or antagonistic, that you cannot have a general odor nuisance from a body of water into which sewage is discharged, while at the same time that body of water shows an oxygen content of thirty-eight per cent oxygen saturation?

A. The two factors are not antagonistic, but they are not necessarily related.

Q. How do you reconcile or explain it?

A. Because nuisance may be caused by other factors than those which relate to the amount of oxygen present.

Q. Can you have an odor nuisance from a body of water that will show an oxygen determination of fifty per cent of saturation and higher?

480 A. I think so; as, for example, there may be a film of oil upon the surface of water which would rightly be regarded as a nuisance, and yet it might be entirely related to the amount of oxygen present in the water beneath. There might be decomposition arising through the water from decomposing mud at the bottom, which would be quite unrelated to the amount of oxygen present in the water over the mud.

Q. How then would the factor of safety which you have pre-

scribed as twenty per cent of oxygen saturation or less, be a guide in determining the capacity for a given body of water to digest sewage discharges?

A. With reference to that part of the nuisance which might be occasioned by the putrefaction of the organic matter, in the absence of oxygen, it does not relate to the other forms of nuisance.

Q. Does it relate to other nuisances?

A. To a part of the odor.

Q. What particular part?

A. That part due to decomposition of organic matter, which is well distributed through the water.

Q. You stated, Mr. Whipple, that in regard to your factor of safety, which you stated to be twenty per cent of oxygen saturation or less, that it would be necessary to take into account the sludge deposits, in order that the working standard might be changed
481 for the factor of safety. To what extent do you take into consideration sludge deposits in prescribing your factor of safety at twenty per cent of oxygen saturation or less?

Mr. Riker: The question is objected to on the ground that the testimony of this witness is not correctly quoted, that the factor of safety in the oxygen content was not related to the sludge deposits.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. In the first place I do not prescribe twenty per cent as a definite figure but use that in an illustrative way, but my thought is that if the sewage of New York were carried out—were discharged well out into the stream, instead of into the slips, as at present, it would be possible to establish a lower working standard for the dissolved oxygen, than if the sewage were discharged at the back end of the slips, as at present, and the sludge allowed to accumulate there. The working standard must depend upon the manner in which the sewage is discharged into the Harbor.

Q. How many sewers discharge at the slips and how many at the pier heads in Manhattan Island?

482 A. I don't know.

Q. To what extent is the bottom of the Upper New York Bay covered with sludge deposits of sewage origin?

A. I don't know that definitely; I have made some examinations of the mud in years past, however, which show that there are deposits of what may be called sewage mud, at certain places in the Harbor.

Q. Have you examined the deposits taken up by the National Government in dredging the Ambrose Channel?

A. No, sir.

Q. Do you know anything with regard to that, directly or indirectly?

A. No, sir.

Q. Do you know anything about the conformation or the topography of the bottom of the Upper Bay of New York that favor the retention of sludge deposits of sewage origin?

A. I know that there are shallows to the west of the main channel which passes through the Harbor, and that the natural tendency would be for the currents to be lower there than in the main channel, and such reduction in the currents would favor the deposition of suspended matter.

Q. Do you know whether or not the sludge deposits from cities, towns and villages between New York and above Troy, as the result of the sewage discharges into the Hudson River are brought
483 down on the freshets in the spring months and are retained in the Upper Bay of New York and are deposited on the floor or bottom of that Bay?

A. I cannot answer that definitely, but the tendency would be for all deposits on the bottom of the Hudson River to be washed down stream, and to a large extent, I believe, carried out through the Harbor into the Lower Harbor, depositing perhaps to some extent on the shallows in the Upper Bay.

Q. Do you know of any obstructions due to the topography of the Upper New York Bay, that prevent the passage of sludge deposits of sewage origin and their carriage into the Lower Bay or out beyond the Harbor's mouth?

A. Only what I have mentioned, and perhaps the effect of docks and other projections into the Harbor.

Q. Have you ever given any study to contour maps of the bottom of Upper New York Bay? Are there many pockets and deep depressions in the Upper Bay of New York?

A. There is one main channel, which is practically an extension of the Hudson River, which passes directly through the Upper Bay from the Battery to the Narrows. There are two or three side passages to that channel, notably one near the Brooklyn shore, and side passages to the docks in Bayonne, known, I believe, as Black Tom and the Pennsylvania docks. I do not recall the pockets to
484 which you refer.

Q. Do you know whether or not the sludge deposits of sewage origin on the bottom of the Upper New York Bay will average over ten feet in the bottom of that Bay?

A. I do not know that such deposits are of sewage origin; I know that there are deep deposits of mud in the Upper Bay, and have taken samples from them.

Q. There have been a great many borings made at various parts of the lower reaches of the Hudson River and in the Upper Bay; do you know of any such borings?

A. Yes, sir; I was present when one or two—when some of them were made.

Q. And how deep down is the rock formation in the Upper Bay of New York?

A. I don't remember.

Q. It is very deep, is it not?

A. I don't remember.

Q. Mr. Whipple, did you use the Winkler method yourself on both of these sets of samples that are in Defendants' Exhibits 8 and 9?

A. Yes, sir, but I was assisted by Mr. Gordon M. Fair on May 3, 1919.

Q. Did you personally secure any or all of those samples?

A. I personally secured more than half of them. I personally made the color tests and part of the dissolved oxygen tests.

485 The chlorine tests were made in my presence by Mr. Fair. The work was done under my personal direction.

Q. Did you select all of the sample stations that are set forth in Defendants' Exhibits 8 and 9?

A. I selected all of the sample stations on May 3, 1919, to correspond with those samples taken on November 3, 1909. I do not recollect just how the samples collected on November 3, 1909, were picked out. I remember that there was a considerable number of people present on that occasion and that the samples were taken during the course of an inspection of the Harbor.

Q. Why were there no samples taken on ebb tides and tested for oxygen content?

Mr. Riker: The question is objected to on the ground that it does not appear that there were no samples taken on ebb tides; it appears that there were some samples taken on ebb tides.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. Because the two trips were taken in the Harbor without regard to the conditions of the tide, and without our knowledge of what the tides would be when we made the trips.

486 Q. What is the velocity of the flood tide in the Upper Bay of New York at say four feet depth?

A. If we regard the flood tide as covering the period of the rising water from low tide to high tide, then I should say that the velocity would vary all the way from a theoretical zero up to three feet or more per second, the reason for that being that the time of slack water is not coincident with the time of high or low water, but occurs at some point between.

Q. Do you know whether or not there is any difference in the velocity of the flood tide at four feet below the surface, at twenty feet below the surface and at forty feet below the surface?

A. I do not from any observations which I have personally made. I assume that there are differences, however.

Q. There are considerable differences, are there not?

A. There may be.

Q. What is the difference, Mr. Whipple, between the velocity of the ebb tides and the flood tides at four foot depth, at twenty foot depth and forty foot depth?

A. I am unable to say.

Q. What is the average velocity of the ebb tide as compared with the average velocity of the flood tide?

A. In the Upper Bay of New York I cannot say definitely but it would probably be slightly larger, inasmuch as a somewhat

487 larger volume of water goes out than comes in.

Q. What is the duration of the ebb current in the Upper Bay of New York?

A. I cannot say exactly, but I suppose about six hours.

Q. And what is the duration of the flood current in the Upper Bay of New York?

A. Substantially the same, there being slight differences which I do not know or do not recall at this time.

Q. Would you consider .94 as compared with 1.25 a slight difference in velocity?

A. That would depend upon the other velocities which were observed, upon the general range of velocities.

Q. Will water samples secured from the stations chosen by you in the tables marked Defendants' Exhibit 8 and Defendants' Exhibit 9, give higher oxygen percentages when taken on flood tides or on ebb tides?

A. That would vary at the different places, but as a rule, speaking generally, the amount of oxygen in the water of the Harbor would tend to be somewhat lower on the ebb tides.

Q. Will water samples taken from flood tides on November 3, 1909, and May 3, 1919, at the stations selected by you, and tested for oxygen as testified by you, give a reasonably fair measure of the oxygen content of New York Harbor waters, at slack water
488 and on ebb tides, during the months of July, August and September, 1918, or to be expected for the same months in 1919?

A. These comparisons could be only approximated.

Q. Would you expect them to be higher or lower?

A. Speaking generally, I should expect the dissolved oxygen to be somewhat lower on the ebb tide at many of those stations, but that does not necessarily hold always.

Q. And as to the months, comparing the months of November and May with July, August and September, how would you expect the oxygen content to show on average percentages?

A. I should expect the dissolved oxygen during the months that you named, July, August and September, to be lower than during May and November.

Q. Are not the anaerobic putrefaction factors more active in July, August and September in New York Harbor waters in the extensive sewage sludge deposits on the bottom of the Upper Bay of New York?

A. Yes, sir.

Q. Do not aerobic and anaerobic bacteria consume oxygen with greater rapidity in the warm months, in biochemical disintegration of refuse organic matter of sewage origin in the New York Harbor waters?

489 A. Yes.

Q. Is not the dissolved oxygen content at its lowest percentage in the summer months when bacterial demand on oxygen is greatest?

A. Yes, sir.

Q. Are these not the conditions from which we get nuisances?

A. Yes, sir, in so far as nuisance from that particular source is concerned.

Q. In your direct testimony you stated that biochemical action

caused oxygen depletion. What is that due to; what function or activity?

A. It is due to the fact that organisms in their life processes, require oxygen, and they utilize the dissolved oxygen in the water in very much the same way that human beings utilize oxygen in the air.

Q. And in the final disposition of organic refuse, oxygen is used at almost every stage in its final disposition, is it not?

A. In the final disposition of the organic matter oxygen is always used.

Q. Have you made any studies with a view to determining the rates of reaeration with fresh distilled water deprived of its oxygen?

A. Yes, sir.

Q. At what rate will the distilled water dissolve oxygen from the air?

490 A. That depends upon whether the water and the air are both still or whether the water and the air are in motion. If both are in motion, the amount of oxygen absorbed by the water is many times greater than in the case of still water, and it may be ten or twenty times greater. I have found by experiment that still fresh water exposed to still air will absorb oxygen from the air, when the oxygen present has a saturation of fifty per cent, at the rate of about 300 cubic centimeters of oxygen per day, per square meter of water surface. These figures compare closely with what other experimenters have found, namely Dr. Addeney, Professor Phelps and others. I have made other experiments with the water in constant motion, and still others with air blowing over the surface of the water, and still others with the water in motion and air also blowing over the surface of the water, for comparison with the experiments made with still water and still air, and have learned that the movement of the water and the movement of the air may increase this absorption tenfold and often twentyfold. If the amount of oxygen present in the water were less than fifty per cent of saturation, then the amount of oxygen absorbed would be increased in a direct ratio to the depletion of the oxygen below saturation.

491 Q. In the determinations that you have just described Mr. Whipple, were you dealing with pure fresh water?

A. They will be the results of different waters, some of them, those in still water and still air—being distilled water, but the others, where the water and air were both in motion; and along with them, some still water experiments were made with the tap water in the city of Cambridge, fresh water.

Q. A potable water, unpoluted?

A. A potable water, unpolluted.

Q. Will organic matter of sewage origin flowing on the surface of water impair or accelerate the rate of re-aeration?

A. It will impair it to the extent that it reduces the surface exposure of the water to the air.

Q. All oxygen dissolved from the air by bodies of water, the solution takes place at the surface and is transmitted to the depths through great vertical currents, is it not?

A. It is dissolved at the surface and is transmitted to the depths, partly by diffusion, which is a slow process, but chiefly by the movements of the water. In fact, these movements of the water influence not only the spread of the oxygen through the water, but its rate of absorption.

492 Q. Have you followed the studies of Birge and Juday with regard to their oxygen determinations in the Great Lakes in Wisconsin?

A. In a general way, yes, sir.

Q. As to the methods with which oxygen is carried from the surface of the water to the greater depth in that body of water, what agencies operate?

A. Chiefly, the currents which may be the vertical currents brought about through temperature changes, but also currents produced by the wind action and horizontal currents induced by the wind, which tends to carry the water towards one side of the lake, where it drops and returns at a lower level, thus making a circulation in the horizontal plane.

Q. What are convection currents, and how do they influence the transportation of oxygen from the surface of bodies of water to the greater depths?

A. We commonly speak of conventional currents as those produced by temperature changes at the surface and below the surface; as the surface water warms, it becomes lighter and tends to remain at the surface, but this condition of stratification may be upset by the wind. Such condition occurs during the day time. At night as the surface of the water chills, it becomes heavier and tends to sink, and this brings about a mixing of the waters through a

493 considerable depth, this depth varying all the way from a few feet up to twenty, thirty or forty feet, under different conditions.

There are also surface changes in temperature which follow the water changes.

Q. Are any of these currents and conditions that you have just testified to influenced when the body of water is heavily polluted, containing much suspended and organic matter in solution, of sewage origin?

A. They are not interfered with excepting as they may affect the absorption and transmission of heat.

Q. And one source of that heat is light rays from the sun?

A. Heat rays from the sun.

Q. Are light rays not transferable into heat rays?

A. To some extent, yes, but they are both from the sun.

Q. And if there is considerable turbidity in a body of water, how will that influence the heat transmission through that body of water?

A. It tends to prevent the penetration of the heat rays in the same way that it tends to prevent the penetration of the light rays.

Q. And in that particular would it retard or accelerate the transportation of the oxygen dissolved at the surface to the deeper layers of water?

A. I don't believe that the difference would be a measur-
494 able quantity.

Q. Is the rate of re-aeration in fresh polluted water and in salt polluted water equal or do they vary?

A. I do not know of anyone who has made experiments to compare the two.

Q. Is the rate of re-aeration in brackish water as rapid as it is in either fresh water or salt water, all three samples of water being polluted?

A. I do not know that any experiments have ever been made; my opinion would be that the rate of absorption is probably a little less in the salt water, inasmuch as this water is heavier and moves somewhat less readily under the influence of wind and temperature. I do not believe that the difference could be very great.

Q. Have you any positive knowledge on that feature of this matter?

A. No, sir.

Q. Directing your attention now, Mr. Whipple, to Defendants' Exhibits 8 and 9, being the oxygen tables for November 3, 1909, and May 3, 1919, as I remember, you state those samples show that the oxygen content was greater in every case in 1919 than it was in 1909; am I correct?

A. I don't think I said every case; I may have said almost every case.

495 Mr. O'Sullivan: I will make that qualification.

Q. You also testified on your direct examination that the population of the City of New York in 1909 was 4,649,300, and that in 1919 the population of the City of New York was 5,966,600 showing an increase of 1,347,300 in those ten years. Am I stating it correctly?

A. That was the mathematical estimate based on the census figures. I have no other basis for any estimate than that.

Q. I mean, I am quoting your testimony correctly, am I not?

A. Yes, sir.

Q. And in answer to a question of mine, I understood you to say that you did not know what the increased number of manufacturing plants discharging trade wastes from the City of New York was during those ten years.

A. That is correct; I do not know.

Q. Do you know whether there has been an increase in the number of manufacturing plants as well as in the population of New York City in the ten years between 1909 and 1919?

A. Only from my general knowledge.

496 Q. That there is an increase?

A. That there has been some increase.

Q. How then do you account for the fact that the waters which you examined in 1919, into which the sewage and trade wastes of the increased population and the increased number of manufacturing plants discharging trade wastes, was delivered should show an

improvement in the water conditions, in view of their added burden?

A. I stated yesterday that I did not pretend to account for this increase. I mentioned one or two difference between the conditions which render the two figures not strictly comparable. I mentioned the fact that they were collected at different seasons of the year; that I did not know that the tidal conditions were just the same; I mentioned the presence of microscopic organisms as a possible factor. I might add that there are always slight differences in the dissolved oxygen to be found in samples collected from points quite near together and at different depths.

Q. Take sample, Station D, in both Defendants' Exhibits 8 and 9, take D at the surface and thirty feet below the surface; take E at the surface and sixteen feet below; F at the surface and twenty-two feet below; G at the surface and fourteen feet below; H
497 at the surafce and fourteen feet below; why were not samples taken at the same stations on May 3, 1919, that you had selected on November 3, 1909. If your object was to make comparisons?

A. These samples were omitted on May 3, largely because time did not permit the entire list to be covered, and Station D was omitted because it was so close to C, that it was thought that a single sample at C would be sufficient. Samples E, F, G and H related more to the water in the vicinity of the Gowanus Canal and less to the water of the Upper Bay.

Q. Mr. Whipple, why did you in omitting these sample stations to which I have just directed your attention, add six new sampling stations in 1919 that you did not select samples from in 1909, your object being to secure samples and determinations that would stand comparison?

A. Because on November 4, 1909, samples were collected at Stations A, N, O, P, Q, and C, which results were not asked for by counsel yesterday.

Q. Directing your attention to the sampling Stations L in both defendants' exhibit 8 and defendants' exhibit 9, L Station at the surface depth showed 75 per cent of oxygen saturation on Novermber 3, 1909, and showed 45.2 per cent of oxygen saturation
498 on May 3, 1919, is that correct?

A. Yes, sir.

Q. There is a loss there between the 1909 and the 1919 samples of 29.8 per cent; how do you account for that exception to be tables that you have furnished as to gains in 1919 over 1909?

A. I do not pretend to account for it definitely. I merely state that those were the results obtained. and to add that it often happens that in collecting samples for a harbor, one will select a sample from a streak of pollution, where the water has not thoroughly mixed with the neighboring water; such occasional differences are always to be expected.

Q. Keeping your attention on that sample Station L as it appears in both exhibits, Defendants' Exhibit 8 and Defendants' Exhibit 9, while the surface oxygen determination shows 45.2 per cent satura-

tion on May 3, 1919, on the same day, the sixty foot sample at the same station showed an oxygen determination of 86.9 per cent; how do you account for the fact that the deep sample at the same station showed almost twice as much oxygen as the surface sample?

A. I don't pretend to account for it exactly, but the reason
499 previously given would be my answer.

Q. The re-aeration process taking place at the surface ought to show a higher oxygen content in the surface sample than at the deeper sample, ought it not?

A. Not necessarily, because the whole question is involved with the incoming salt water, with the difference in density at the different elevations, with the mixing of the water under the effect of currents and wind &c.

Q. Did that carry to your mind the impression that you had taken the deep sample from the undertrun and the surface sample from the ordinary flood waters that are returning to the Harbor?

A. Not necessarily. I was more inclined to think that the surface sample represented some abnormal streak of polluted water at that point.

Q. After you had read both these determinations on the boat where you had taken both samples, and within a short time of each other, did you make any effort to determine what occasioned that great discrepancy between the oxygen content of the two samples taken at the same station at the same time practically?

A. No, sir, because the final determination was not made on the boat, but at my office.

Q. Do I understand that part of the oxygen determination
500 were made at the office?

A. The first part of the test was made on the boat; the final titrations were made on all the samples at my office.

Q. And at no time during that testing of these samples in Defendants' Exhibit 8 and 9 did you make any determinations of the nitrites present in the water samples?

A. We did not.

Q. In your direct testimony, Mr. Whipple, in stating that New York Upper Bay would serve more than thirty millions of people, if a low oxygen content was allowed, what factors did you take into consideration with regard to the capacity of these waters for digesting such a volume of sewage and trade waste as would be incident to that conditions?

A. As I remember my statement, it was that I could not name any particular population which would represent the limit for the discharge of sewage into New York Harbor without objectionable conditions arising, but I have made some computations: one of them was based on the well known fact that four cubic feet of water per second for each 1,000 persons is regarded as a sufficient dilution to prevent nuisance during the summer conditions. This is equivalent to a supply of 175,000 pounds of oxygen a day for each
501 million persons. I have estimated that the amount of oxygen likely to be present in the New water from the ocean and from the river which enters the harbor during the summer season,

assuming a temperature of twenty degrees centigrade, and assuming that two-thirds of the new water is sea-water, and one-third land water, is 2,670,000, pounds of oxygen per day. This figure divided by 175,000 gives about 15,000,000. That is to say, the amount of oxygen present in the new water which enters the harbor during the summer season should be sufficient to supply oxygen to the sewage of 15,000,000 people. In addition to this, allowance must be made for the oxygen derived from the air. This depends upon the area of the Harbor, upon the amount of oxygen already in the water, and upon the movement of the water, and it is impossible to make a very close estimate of what this amount would be. If the amount already present in the water is considerable, the absorption will not be great. If the amount of oxygen already present is small, the absorption will be considerable and I believe might at times equal the amount present in the entering water, or in the new water which enters the Harbor, which added to the preceding, would give oxygen sufficient for the population of 30,000,000, people, but I do not wish to be regarded as stating this figure with any degree of confidence,
502 because I believe that no one can tell how much oxygen will be absorbed from the air, because no one has any way of finding out the movements which occur in the water, but I believe that the oxygen absorbed from the air in the process of re-aeration, is a very important factor, in the problem, and one which will increase in importance as the oxygen in the water of the Harbor becomes depleted.

Q. You use the terms "sufficient", "small", "great", in your answer with regard to oxygen present; what do you wish to be understood as meaning when you say, "when the oxygen is great", "When the oxygen is small" and "when the oxygen is sufficient"? I wish you to define what you mean by these terms in relation to the oxygen content.

A. I used these terms in a general way as indicating the range of dissolved oxygen from zero to 100 per cent. I can express my ideas a little more definitely: If, for example, the percentage of dissolved oxygen present were 70 per cent, and if the oxygen absorbed by a certain area of the Harbor were 57,700 pounds per day; then if the dissolved oxygen in the Harbor were reduced to 50 per cent of saturation, the amount of oxygen absorbed would be 96,200 pounds per day. If the dissolved oxygen present were only 10 per
503 cent, then the oxygen absorbed would be 173,000 pounds per day. These figures were based upon the absorption of oxygen by still water exposed to still air for an area of about thirty-nine square miles.

Q. I wish to get that a little more definite, Mr. Whipple, and will ask you if 70 per cent of oxygen saturation would be included in your term of "great" as applied to the amount of oxygen content present; in other words, I wish to translate into percentages the terms which you have used in your answer to me—The terms "great", "small", "sufficient", as applied to the oxygen content in waters capable of accommodating 30,000,000 people for their sewage discharges and for the digestion of their organic refuse.

A. I had in mind seventy per cent as a great amount of oxygen, from the standpoint of oxygen absorption from the air. I was thinking of those statements rather in terms of the depletion of the oxygen than of the amount left in the water.

Q. For the term "small", if any oxygen determination was made, what percentage of the oxygen content present would come under that term "small"?

A. Ten per cent would.

Q. When you use the term "sufficient", what would be the oxygen content that would be properly expressed as to oxygen saturation by the term "sufficient"?

504 A. I don't think I used the term "sufficient" in regard to the percentage of saturation.

Mr. O'Sullivan: I so have it, but perhaps I am in error.

Q. In addition to the terms "small" and "great," representing ten per cent and seventy per cent, respectively, of oxygen saturation, what would you consider then the factor of safety that might be sufficient for 30,000,000 of people discharging their organic refuse into New York Harbor waters?

A. I have always stated that I regarded—but I am unable to give a definite figure—something in the vicinity of twenty per cent as a reasonable figure as a working standard and that would not be influenced by the population.

Q. One of the factors that you took into your estimate when you stated that the Upper Bay of New York would accommodate the organic refuse for more than 30,000,000 of people, was that you would get good diffusion and dispersion?

A. I presuppose a good mixture of the sewage with the water, and I further limited this to the oxygen relation of the water, and not to any other factors of the sewage which might cause nuisance.

505 Q. And in stating the number of people that could be accommodated without nuisance with regard to the digestion of their organic refuse in the Upper Bay of New York, did you take sludge deposits into consideration?

A. Yes, sir, in the manner in which I have already described.

Q. And with existing conditions as you now know them to be in the Upper Bay of New York, you state that that Bay would accommodate the organic refuse of thirty millions of people?

A. No, sir, I didn't state that. I would not wish to state that in just that way.

Q. How do you wish to answer that then?

A. Merely that on the basis of these assumptions, the mathematics of the situation would indicate that the oxygen present in the new water which enters the Harbor, and which is absorbed from the atmosphere, would be sufficient to digest the organic matter without reducing the oxygen in the water to the danger point, that is, to zero per cent.

Q. Will you admit that it is necessary,—as one witness testified already, at this hearing, that these deposits of sewage origin ought

to be dredged out in order to accommodate a larger number of people with their sewage disposal in the Upper Bay of New York?

506 Mr. Riker: The question is objected to on the ground that no witness, as it will appear by the record, could have said that, but the statement of the witness being that the discharge of the sewage into the deeper water along the Manhattan shores in connection with the removal of the sludge along the shores, would remove the local nuisance.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I do not recall the testimony referred to, but I believe that the sludge deposits should be removed from the vicinity of the sewer outfalls from time to time in order to prevent local nuisance.

Q. And would that removal also necessitate the removal of the present sludge deposits of sewage origin on the bottom of the Upper Bay of New York?

A. I doubt if it will be possible to remove the deposits on the shallows of the Upper Bay with any degree of regularity.

Q. Would it be necessary to remove these deposits of sludge of sewage origin in the Upper Bay of New York in order to accommodate the thirty millions of people whom you state that the Upper Bay of New York could accommodate, for digesting their organic refuse?

507 A. I think not.

Q. On what did you assume that you would get good diffusion and dispersion of sewage discharges in the Upper Bay of New York; did you experiment with floats or with colors or with other means of determining what the diffusion or dispersion is that now takes place in the Upper Bay of New York?

A. I don't think I made that assumption that there would be good diffusion and dispersion.

Q. I have your statement, Mr. Whipple; "I am assuming good diffusion and dispersion" as a part of your answer, in stating that thirty millions of people could be accommodated for digesting their organic refuse, if a low oxygen content was allowed.

A. I made that assumption in connection with the mathematical statement of the case; I have not assumed that that was the case in fact. As a matter of fact, the dispersion and diffusion of the sewage of New York at the present time is not good, but is discharged along the shore at points near the shore.

Q. What condition did you find the Gowanus Canal and the Newtown Creek in during your tour of inspection as to pollution conditions?

A. In 1919, I found the water of the Gowanus Canal to be in much better condition than I remember to have seen it in, 508 ten years before, but still showed evidences of pollution in May, 1919. I saw particles of fæcal matter floating at the surface in places, but in particular I was impressed by the large amount of oily matters on the surface of the water, and which not

only covered the water in the Upper parts of the canal almost completely, but which covered the piles and wharves.

Q. Do you regard the Gowanus Canal and Newtown Creek as heavily polluted bodies of water?

A. Yes.

Q. In view of your testimony with regard to the reaeration processes of New York Harbor waters, how do you account for the lack of proper oxygen content in those two bodies of water?

A. Because of the very heavy pollution which the waters received, because of the relatively quiet condition of the water in the canals, and to some extent because of the oily deposits found upon the surface.

Q. Which prevents oxygen absorption from the air, does it not?

A. If these films are sufficiently thick, they do prevent the absorption of oxygen from the air.

Q. You found oily films in the neighborhood of Robbins
509 Reef?

A. Yes, very thin ones.

Q. How thin; did you measure them?

A. No, sir, but from my past experience I should say that they were such a thickness as would be obtained by putting a drop of oil on about one square yard of water surface.

Q. In measuring good diffusion and dispersion, did the samplings taken at Station L, in Defendants' Exhibits 8 and 9, which showed considerable discrepancy between the surface and the sixty foot depth samples, of relatively 45.2 per cent and 86.9 per cent did that impart to your mind at all that there was not in some areas the diffusion and dispersion that you have assumed?

A. I think they showed a lack of dispersion of the sewage at that particular point, but my assumption related not to fact, but merely to my mathematical computation.

Q. What is the volume of sewage discharge into the Passaic River now, approximately?

Mr. Riker: The question is objected to as not cross examination.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I don't know.

Q. What is the dilution ratio between the volume of water in the Passaic River at high tide and the volume of sewage and
510 trade waste discharged into the Passaic River?

Mr. Riker: Same objection.

Commissioner Maher: The objection of counsel for defendants will be noted.

A. I don't know.

Q. In your direct testimony, Mr. Whipple, you were asked questions relating to the Passaic Valley sewerage District and you gave the population of the Passaic Valley Sewerage District in 1906 as 574,264; is that correct?

A. 574,264 is correct.

Q. And you gave the population for the same district in 1910, as 736,449; is that correct?

A. Those are the figures given by the Federal Census.

Q. Do you recall the estimate of the population of the Passaic Valley Sewerage District made in the report of Mr. Hazen and yourself to the City of Paterson in 1906?

A. I remember that an estimate was made, but I don't remember what it was.

Q. That the population then for 1905 was given as 769,778, which is in excess of the population that you have just given for 1910?

A. I don't remember that from the report, no, sir.

Q. Where do you get your figures for the two populations that you have given now for 1905 and 1910?

A. From a list of the places stated on the page 137 of the
511 Paterson report.

Q. Where did you get your figures for the population of the Passaic Valley in 1915, that you set down in your direct testimony as 805,630?

A. I obtained them from the New Jersey State Census of that year?

Q. What cities and townships did that include, do you know?

A. The list which is given on page 137 of the Paterson report. Shall I read this list?

Mr. O'Sullivan: I don't think it will be necessary.

Q. You gave the percentages of increase for the various years that I have drawn your attention to. What do you estimate the percentage of increase from 1915 to 1919, the present year, to be in the Passaic Valley Sewerage District?

A. I have no means of estimating that.

Q. Do you know whether or not it has increased materially as to population and as to manufacturing plants?

A. Only from general knowledge, and I assume from my general knowledge of Newark, that the increase in this city at least has been considerable.

Q. In testifying in relation to the Passaic Valley Trunk Sewer outfall plans, if my memory serves me right, you stated, "I have not made a critical study of these plans, but I think they
512 ought to be effective." Do you recall that?

A. I made some such statement; I have forgotten just how I phrased it.

Q. What study did you make of these plans of the trunk sewer project and the sewage disposal system?

A. I had handed to me the plans which showed the proposed settling basins, screens at the end of the trunk sewer, the outlet tunnel, the distributing pipes which are to be placed in the Harbor near Robbins Reef, the outlets which are connected with those distributing pipes, and I have also seen these outlets as they now stand on the shore ready to be placed.

Q. Is there any provision there made for the destruction of pathogen bacteria before the sewage is discharged at the outfall at Robbins Reef?

A. No, sir, but should bacteria be present in the sewage, some of them would doubtless be removed from the sewage in the sludge which will result from sedimentation, and which I understand is to be removed from the sewage and discharged somewhere off the coast, at sea.

Q. What is the detention period in the sedimentation basins?

A. I think the plan is for the flowing sewage to be detained for a period of one to one and one half hours.

Q. Do you know anything in relation to the grade or slope
513 of the trunk sewer as it travels between Paterson and the Newark Meadows?

A. I have seen the grade stated on the plans, but I have made no critical study of it.

Q. Is it a very light or moderate or heavy grade?

Mr. Riker: The question is objected to as not cross examination, there being no examination in chief on the subject.

Commissioner Maher: Note the objection of counsel for the defendants.

A. From my present information I am unable to answer that.

Q. In what condition, from your studies of the Passaic sewerage plans, would you expect the sewage to be in when it reached the disposal works on the Newark Meadows?

Mr. Riker: The question is objected to as not being cross examination, no questions having been asked as to the character of the effluent when discharged at Robbins Reef in the Passaic Valley sewerage system.

Commissioner Maher: Note the objection of counsel for defendants.

A. I haven't studied the question from that point of view.

Q. Was your attention directed to the report of Hering & Fuller made to the Passaic Valley Sewerage Commissioners on December 31, 1907, in which they stated that the sewage as received
514 at the pumping station will doubtless be septic and blackened?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I remember reading the report at the time we were making our investigation of the sewage question in Paterson.

Q. Did you read Professor William T. Sedgwick's testimony in regard to the condition in which the sewage would reach the sewage disposal works on the Newark Meadows, and in which he stated, "In summer I should expect it to be destitute of oxygen, and even in a stinking rotten condition, a condition commonly described as distinctly septic"; do you recall that part of his testimony?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I don't recall that in particular, although I remember reading his testimony in a general way.

Q. What do you understand to be the treatment that will be accorded to the sewage when it reaches the sewage disposal works on the Newark Meadows?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for de-
515 fendants.

A. I understand it will pass through screens and then pass through sedimentation tanks provided with scum boards and that it will then be discharged into the outlet pipes which will go to Robbins Reef.

Q. In what condition would you expect to find that sewage at Robbins Reef as to its septicity?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I should expect to find it septic.

Q. What are the relative capacities of sea-water, land water and brackish water for absorbing and holding in solution gases of putrefaction from septic sewage?

A. I do not know.

Q. Have you performed any experimental work to determine these facts?

A. Not with such gases, no, sir.

Q. Can you answer what conditions result from the discharge of septic sewage in brackish water and how that result would differ from a like discharge in fresh water?

A. About the only difference that I can see would be the fact that the salt water, brackish water, would contain less oxygen than fresh water—that it would have the power of holding less oxygen than fresh water, and that the differences in density of the water,
516 containing salt would make some differences in the movement of the water.

Q. What factors eliminate putrid odors from waters into which septic sewage has been discharged?

A. The oxidation of these compounds and their physical removal in the air.

Q. And that oxidation process is a direct chemical one?

A. To a certain extent it is a direct chemical one.

Q. How much sulphureted hydrogen will one volume of fresh water absorb at normal barometric pressure and at 60 degrees of Fahrenheit temperature? Do you remember?

A. I don't remember.

Q. Is the quantity of malodorous gases which a liquid can dissolve

or absorb, independent of the nature and quantity of other gases which it may already hold in solution?

A. Practically independent. And I may say in reference to the preceding question, if I may go back to that, that the solubility of the hydrogen sulphide gas would depend upon the amount present in the atmosphere.

Q. And how would that be with regard to methane or marsh-gas?

A. Just the same.

517 Q. In selecting Robbins Reef as the point of outlet for the Passaic Valley Trunk Sewer, was there unanimity of opinion at the time that this report was gotten out for the City of Paterson in 1906?

A. I think not.

Q. What was the point of divergence as to selecting that site?

Mr. Riker: The question is objected to as not being cross-examination, and being immaterial and irrelevant.

Commissioner Maher: Note the objection of counsel for defendants.

Mr. Riker: And further objected to on the ground that this independent question is not within the purview of the order of the United States Supreme Court under which the testimony is being taken.

Commissioner Maher: Note the further objection of counsel for defendants.

A. I do not know; I simply know that various sites were proposed by different individuals.

Q. I call your attention to the report on sewage disposal of the City of Paterson, New Jersey, to which your partner Mr. Allan Hazen, and yourself contributed, and see if it will refresh your recollection; I read from page 28:

518 "With regard to the Robbins Reef outlet, such a diversity of opinion exists among the engineers as to the probable nuisance that would be created by the Passaic Valley sewage if allowed an outlet at this point, that it would be advisable to have the combined action of the New York and New Jersey Sewerage Commissions to determine whether this outlet would be practical."

Do you recall that adversity of opinion as to this objection?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I remember what you have read.

Q. From the same report I also read, at page 93, and ask you if it refreshes your recollection:

"It must be admitted that New York is better off without the discharge of New Jersey sewage. The discharge of sewage will tend to pollute the Bay locally. There will be an appearance of sewage for some distance around the proposed outlet, and this outlet is near the main channel up the Harbor. There will be some odor, and grease

from the sewage will smooth the waves and show its presence over a considerable area."

Do you recall that part of the report?

Mr. Riker: This question is objected to on the ground that it is not even intended that it is asked to refresh the witness's memory as to anything that he has been asked to testify on, and is manifestly intended to read into the record something that does not belong there, and is not within the purview of the order of March
519 10, 1919.

Commissioner Maher: Note the objection of counsel for the defendants.

A. Yes, but my recollection is that the statement refers to the discharge of raw sewage at that point.

Q. If sewage is comminuted after several pumpings and in an advanced septic condition, will screening and sedimentation remove the organic matter in suspension?

Mr. Riker: The question is objected to as not being cross-examination, and not being material or relevant, and not being within the purview of the order of March 10, 1919, under which this testimony is being taken.

Commissioner Maher: Note the objection of counsel for defendants.

A. Screens will not, unless the screens be fine, but some of the matter which you spoke of will be removed by sedimentation through the coagulation and matting together of some of the small particles in the settling basins.

Q. Do you consider screening and sedimentation complete treatment for sewage?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

520 A. It is not a complete treatment if we regard the matter from the ultimate standpoint, but it may be a complete treatment from the standpoint of doing all that may be necessary in that particular situation.

Q. How do you describe screening and sedimentation as planned for by the Passaic Valley Sewerage Commission, either as a preparatory process or putrefaction proocess or a finishing process?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I should say that in this situation it was a finishing process, and the last process to be applied to the sewage, but these processes in other situations are often regarded as preliminary processes to further treatment, where such further treatment is necessary.

Q. I call your attention again, Mr. Whipple, to the report of Sewage Disposal for the City of Paterson, New Jersey, compiled by Allan Hazen, your partner, and yourself, dated, 1906, and read from page 48 of your own report.

"Classification of methods with regard to sewage disposal.

Preparatory processes:

Screens,
Roughing filters,
Plain settling tanks,
Detritus tanks,
521 Chemical precipitation tanks,
Septic tanks.

I ask you if you regard those as preparatory processes as you did in 1906, in your report to the City of Paterson?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I do, speaking generally. They are regarded as preparatory processes because it is very common to have them followed by other methods.

Q. I continue reading from page 48 of your report, Mr. George W. Whipple:

"Purification processes:

Subsurface irrigation,
Broad irrigation,
Intermittent filtration,
Contact beds,
Sprinkling filters."

And I now ask you if you regard those processes that I have just read from your report of 1906 to the City of Paterson, as purification processes?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I say "yes," but it might be better to call them oxidation processes.

Q. Are any of those processes planned for by the Passaic
522 Valley Sewerage Commission?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. Not as far as I know.

Q. I still read from the report at page 48, under the heading of "Classification of methods with regard to sewage disposal," and read the column:

"Finishing processes:

For clarification:
Settling basins,
Coarse filtration.
For bacterial improvement:
Land treatment,
Sand filtration,
Mechanical filtration,
Disinfection."

Do you regard those now as finishing processes in sewage disposal systems?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. Yes, sir, in the same sense that I used the terms then.

Q. Are any of those processes contemplated to be used in the plans and specifications of the Passaic Valley Sewerage Commission, as you have had an opportunity to investigate them?

Mr. Riker: Same objection.

523 Commissioner Maher: Note the objection of counsel for defendants.

A. I believe not.

Q. I still read from page 48 of your report to the City of Paterson in 1906, under the heading of "Preparatory Processes":

"Raw sewage cannot be economically purified by direct application of any single process. This is on account of the complex character of its constituents. A liquid which contains substances, both organic and inorganic, in which a part of each is in solution and another part in suspension, and in which the suspended particles vary in size from banana skins down to the ultra microscopic; a liquid which is continually altering in composition and in decomposition as well, and a liquid continually varying, not only in quality but in quantity, cannot be easily rendered free of its obnoxious ingredients."

I now ask you, Mr. Whipple, if this quotation which I have just directed your attention to, represents your opinion now with regard to preparatory processes?

Mr. Riker: The question is objected to on the grounds already stated in the last objection, and for the further reason that no testimony in the direct examination related in any way to this question asked the witness which is now objected to.

Commissioner Maher: Note the objection of counsel for defendants.

A. Yes, sir.

Recess.

524 Q. What is the chief object in purifying sewage?

A. To remove such impurities from the sewage that it may safely be discharged into some body of water?

Q. Safely?

A. I mean by "safely" that it may be discharged into some body of water in such a way that it will cause no injury to health or no public offense.

Q. During your sojourn in England and your investigation of their sewage disposal systems, did you give much thought or study to disposal by dilution?

A. Yes, sir, because in almost every case that came in in connection with the body of water into which the sewage was discharged, and in particular I looked into the dilution question in the Thames River, where the sewage after chemical treatment was discharged from the City of London.

Q. What is the object of chemical treatment?

A. To obtain a somewhat greater removal of the suspended matter than can be obtained by the ordinary process of sedimentation, and to obtain that result in the shortest space of time.

Q. The chemicals used are used with a view to precipitating the suspended matter, are they not?

A. Yes, sir.

Q. In designing works for purification of sewage is it im-
525 portant to know the character of the sewage to be dealt with in those sewage disposal works?

A. Yes.

Q. And from what standpoint do you consider sewage with regard to its character?

A. You consider the amount of organic and mineral matter present, the physical condition of both the organic and the mineral matter, and the presence of several particular chemical substances that might have an influence on the purification processes—or treatment of the sewage, as I prefer to call it.

Q. And in designing these works for sewage purification, you have to take into consideration the age of the sewage when it will reach the disposal system or works?

A. To some extent, yes.

Q. To what extent, Mr. Whipple?

A. It has some effect on the size of the sedimentation basin, upon the fineness of screens, upon the oxidizing processes.

Q. Assuming that the sewage is septic and highly comminuted when it reaches the sewage disposal works, how fine would it necessarily be for the meshing of the screens that you would use?

Mr. Riker: Same objection.

526 Commissioner Maher: Note the objection of counsel for defendants.

A. I cannot give a definite answer to that, because so much depends upon the character of the body of water into which the sewage is to be distributed.

Q. If it is in an advanced stage of decomposition and fine-comminuted, would any screens retain any considerable percentage of the sewage?

Mr. Riker: Objection is made to the question on the ground that it is hypothetical in form and does not deal with any fact proved in this hearing under the order of March 10, 1919.

Commissioner Maher: Note the objection of counsel for defendants.

A. In proportion as the suspended matter is finely divided, screens become less serviceable in removing suspended matter.

Q. What is the finest screen that you know of that is in actual practical operation anywhere in sewage disposal works?

A. I think that screens with mesh finer than one-eighth of an inch are rarely observed or used.

Q. Is that the finest one you know of, Mr. Whipple, one eighth of an inch?

A. I think I have seen screens somewhat finer than that, but I cannot say just now where those screens were.

527 Q. Do certain trade wastes exercise a very injurious effect on the character of the sewage from houses and from domestic establishments?

A. Certain trade wastes sometimes affect the domestic sewage in such a way as to make it somewhat more difficult to apply certain methods of treatment.

Q. Taking the Passaic Valley sewerage district do some of the manufacturing establishments there produce large volumes of trade wastes that are very difficult to treat?

Mr. Riker: The question is objected to on the ground that it is not cross examination.

Commissioner Maher: Note the objection of counsel for defendants.

A. Yes, sir.

Q. In your direct testimony, Mr. Whipple, you stated that you were the author of a work on Typhoid Fever?

A. Yes, sir.

Q. And Professor William T. Sedgwick of the Massachusetts Institute of Technology wrote the introductory in that work, did he not?

A. He did.

Q. Are the excretions of men and animals the principal original vehicles of infection and contagion with regard to infectious and contagious diseases?

Mr. Riker: Same objection.

528 Commissioner Maher: Note the objection of counsel for defendants.

A. That is true of certain diseases, not of all.

Q. What diseases?

A. Typhoid fever, cholera, certain forms of dysentery, rabbit diarrhea, in general the intestinal diseases.

Q. Is tuberculosis a water borne disease?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. No, not so far as we know at the present time.

Q. Do they find tuberculosis in other animals than in the human animal?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. They find certain forms of tuberculosis in animals.

Q. Is typhoid fever an endemic disease in this region here—the Passaic Valley Sewerage District?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. Generally speaking, I should say no, although in most communities of this size there is some typhoid fever every year, but it is a lessening quantity.

529 Q. Is it not a fact that in order to acquire the infectious disease known as typhoid fever, we must take into our system the excretions or excreta of someone who has been infected by that disease?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for the defendants.

A. No, sir. It is necessary, however, that we take into our system the typhoid fever bacilli from some other case of typhoid fever.

Q. You do not intimately associate typhoid fever with human excrements as a source of infection?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. It very often is associated with excreta, but not necessarily so.

Q. How can you acquire typhoid fever without importing into the digestive apparatus the bacillus typhosus through the excrement of someone who had been infected with that disease?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. By getting into the system bacillus from some previous
530 case of typhoid fever which did not leave the sick person in the excrement. The bacilli of typhoid fever are sometimes eliminated through the perspiration or through the mouth.

Q. In using the term "excreta," what do you include in that term?

A. Ordinarily we include fecal matter from the intestinal tract and urine.

Q. Isn't perspiration also excreta?

A. It is, using the word in the broad sense, but in the sense in which it is commonly used by sanitarians, it refers to the fecal matter and urine.

Q. Is typhoid fever a water borne disease?

A. It is.

Q. And you can get it either from drinking potable water that has been infected with typhoid excreta, or by bathing in harbor waters that have been polluted by excreta from infected typhoid patients, can you not?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. You can, but the number of cases known to have been acquired through bathing in polluted waters is extraordinarily small.

Q. You stated earlier in your direct examination that you
531 had studied some of the exhibits in this case, The State of New York against the State of New Jersey, and Passaic Valley Sewerage Commissioners; I ask you if you read the first exhibit, the testimony given before the Harbor Line Board in December of 1908?

Mr. Riker: Objected to on the ground that it is a misstatement to say that he testified to that on his direct examination.

Commissioner Maher: Note the objection of counsel for defendants.

A. I don't remember that particular report.

Q. Do you recall the testimony where in that you have read in this case, the evidence given by Dr. Darlington, Municipal Commissioner of Health of the City of New York, in which he stated that they had satisfactorily traced typhoid infection to the handling of driftwood removed from the Upper Bay of New York?

A. I don't remember reading that, but I heard that statement made.

Q. Is it your opinion that the subject of proper disposal of sewage is one of the first necessities of sanitary science and of public health?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

532 A. Yes.

Q. Do you regard infected water as a dangerous vehicle of infection with regard to communicable infectious diseases like typhoid fever?

A. Yes, if there is any possibility of that water getting into the mouths of human beings.

Q. In order to make such water safe, is it necessary to disinfect the effluent discharged into such water, for the purpose of destroying the pathogenic germs in the effluent?

Mr. Riker: Do you include potable waters in that question?

Mr. O'Sullivan: All waters.

A. I should say Yes, if there is a probability that the water is likely to get into the mouths of human beings.

Q. Is it a common thing for those bathing in harbor waters to swallow some of the water in which they bathe?

A. From my general knowledge, I should say no.

Q. Do you regard the bacillus typhosus as a germ that occasions typhoid fever? Are you aware of any recent investigations which show that the germ that occasions typhoid fever is a protozoan, and that the bacillus is merely the food for the germ that occasions the disease?

A. I am not familiar with that.

Q. Will aeration destroy the pathogenic germs in the
533 sewage effluent?

A. No, sir.

Q. May water be bright and attractive to the eye, and even acceptable to the palate, and still contain millions of disease germs?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for the defendants.

A. Yes, but it is not likely to.

Q. You say it is not likely?

A. In practice.

Q. I quote from page 165 of Professor William T. Sedgwick's work of "Public Health":

"Water may appear bright and attractive to the eye and be acceptable to the palate, while yet containing myriads of disease germs."

Is your opinion contrary to the quotation which I have just read?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for the defendants.

A. It is not. I think that it may occur as Professor Sedgwick states, but that in practice it is not likely to occur, and seldom does.

Q. Do you regard the ravages in the United States of
534 typhoid fever as appalling in any degree?

Mr. Riker: Question objected to for the same reason, and for the further reason that this witness is not qualified as a medical man.

Commissioner Maher: Note the objection of counsel for defendants.

A. Not at the present time; that was formerly true.

Q. How long ago was that true?

A. Fifteen or twenty years.

Q. When was your book on Typhoid Fever published?

A. Have you a copy of it there? I have forgotten the date.

Q. 1908.

A. In 1908. (Examining book.) That is eleven years ago.

Q. I quote from page 284 of the work testified to by this witness, in which he stated he is the author of the book on Typhoid Fever published in 1908:

"Conclusion. When the appalling ravages of typhoid fever and the accompanying great financial losses are considered, the sums spent in preventing the disease appear beggarly. This is true all along the line from the government of the nation to that of the smallest village."

Is that conclusion of yours, as expressed in 1908, true today, Mr. Whipple?

Mr. Riker: Same objection.

535 Commissioner Maher: Note the objection of counsel for defendants.

A. It is not true to the same extent, because there has been an almost universal decrease in the typhoid fever death rate in the United States since that time, this death rate being steadily decreasing.

Q. In examining a sewage effluent how would you determine whether or not there were pathogenic germs contained in the effluent?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. There is no way by which we can definitely tell whether or not they are present; there are methods which are in use which will enable the typhoid fever bacillus to be identified, but these methods are not entirely reliable. There are methods also which will enable one to tell whether the cholera bacillus is present. None of those methods are in common use.

Q. May water contain the ova or larvæ of some of the endoparasites of man and yet escape detection by the microscope?

Mr. Riker: Same objection.

536 Commissioner Maher: Note the objection of counsel for defendants.

A. Yes.

Q. Can a miscroscopical examination of the sewage effluent determine whether or not there are pathogenic germs contained in the effluent?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. A microscopic examination alone cannot.

Q. Will disinfection destroy the pathogenic germs in the sewage effluent?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

Q. And if so, will you please name the disinfectants that would be so successful?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I know of no disinfectant which can be absolutely depended upon to destroy the pathogenic bacteria in sewage effluents. Such a disinfectant as chloride of lime or liquid chlorine will remove a considerable percentage of what may be present, but if there
537 is any suspended matter in the effluent, the removal of the pathogenic bacteria by the use of a disinfectant will not be complete.

Q. Did you recommend to the Passaic Valley Sewerage Commissioners or any of their representatives the necessity for applying disinfectants to the sewage effluent to be discharged from the Passaic Valley Trunk Sewer at Robbins Reef?

Mr. Riker: The question is objected to on the same grounds, and on the further ground that it is obscure.

Commissioner Maher: Note the objection of counsel for defendants.

Mr. Riker: It does not appear what is meant by "recommend the necessity."

A. No, sir.

Q. Do sewage bacteria multiply at a rapid or at a slow rate?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. Sometimes rapidly and sometimes slowly, depending upon conditions.

Q. Are you familiar with Professor Cohn's estimate of the
538 rapidity with which bacilli can multiply under favorable conditions?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I don't remember it at the present time, but I probably have seen it.

Q. I quote from work on the Purification of sewage and Water, 3rd. Edition, 1903, published in London by W. J. Dibdin, page 14:

"After 24 hours the descendants of a single bacillus would weigh 1/2666 of a grain; after two days over a pound; after three days 16,500,000 pounds or 7366 tons."

Does that accord with your memory on the rapidity with which bacilli will reproduce under favorable conditions?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. Those figures are merely mathematical computations, which indicate rapid multiplication of bacteria. Taken absolutely they mean little or nothing.

Q. Do they mean sufficient, in your opinion, to justify the statement that bacilli in sewage multiply with great rapidity?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

539 A. They illustrate the fact that under certain conditions bacilli in sewage do multiply—or may multiply very rapidly.

Q. As to the viability of the bacillus typhosus in sewage effluents, how viable are they, in your opinion?

A. I do not know definitely, but they will probably exist in sewage effluents, if present there, for a period which may be measured, by saying a few days; whether many tons of them will live more than a week or two is practically unknown.

Q. Does that hold good of fresh water, salt water or brackish water, the answer that you have just given?

A. My opinion is from experiments which I have made, that typhoid fever will persist longer in fresh water than it will in the effluent which you mention.

Q. How long will that be in fresh water, their longevity?

A. It is impossible to give a definite limit, but after a period of about a week or so perhaps 10 per cent of the bacilli may remain alive. After a period of a month, perhaps one per cent may be alive. I do not think that anyone knows the ultimate life of the typhoid bacillus, either in water or in sewage or in sewage effluent.

Q. Have you read the experimental investigations of Levy & Kayser with regard to typhoid bacilli?

540 A. I suppose I have, but I don't recall the particular article.

Q. Do you recall the experimental investigations of Boyce & Herdman with regard to typhoid bacilli in sea-water?

A. I don't remember that article as you describe it.

Q. And that they found typhoid bacilli would live in sea water for over a month?

A. I don't remember the article, but that would be within the statement which I made.

Q. Are you familiar with the experimental investigations of Foster & Freytag, with regard to typhoid germs in salt water?

A. Those names sound familiar, but I cannot recall the particular article.

Q. Do you know whether or not the bacillus coli is a common inhabitant of sewage and of sewage effluent?

A. It is.

Q. Is it used as an index of sewage pollution in determining the condition of a given sample of water?

A. It is.

Q. Do you know whether or not the bacillus coli communis is regarded as a transitional stage or condition for the bacillus typhosus?

A. I don't think it is so regarded generally; I have heard
541 that theory presented as a speculative theory, but nothing more than that.

Q. Are you familiar with Dr. H. R. Kenmore's work laid before the British Medical Association, in which he undertook to show that the typhoid bacillus was merely an evolution from the b. coli?

A. No, sir, I am not familiar with that.

Q. May a single disease germ prove fatal if taken into the human system from a sewage effluent discharged in harbor waters?

Mr. Riker: If you know.

Commissioner Maher: Note the statement of counsel for defendants.

A. Not unless it multiplies very greatly in the system.

Q. Are you familiar with the experimental work of Dr. Cheyne with regard to the minimum dose of disease germs that will induce infection?

A. No, sir.

Q. There are enormous numbers of bacteria found in sewage and in sewage effluents under ordinary conditions, are there not?

A. Yes, sir.

Q. Have you ever made any estimates of their numbers in a small amount of sewage or sewage effluent?

542 A. Yes, sir, I have many times determined the number of bacteria present in sewage and sewage effluents by our ordinary culture methods.

Q. Will they run as high as 7,000,000 in one cubic centimeter of sewage effluent?

A. Not often in the sewage—I will answer yes, but not ordinarily.

Q. If it is desirable to reduce the danger of transmitting disease by sewage contaminated waters to a minimum, what would you recommend as the remedy to induce that reduction?

Mr. Riker: If you understand the question. I don't. "What do you recommend the remedy for that reduction"?

A. I should recommend that that water be kept out of people's mouths.

Q. And no other remedy is feasible that you know of?

A. If it were a public drinking water, there are remedies which could be applied.

Q. For what purposes are sewage effluents disinfected?

A. Sometimes to prevent the bacteria in the sewage effluent from getting in the shell fish, and thus into people's mouths eating shell fish; sometimes to check decomposition of the organic matter in the effluent until it shall have become mixed with a large volume
343 of water.

Q. Would you apprehend any danger from a highly infected sewage effluent discharged into a body of water in which people are in the habit of bathing, and would you deem it advisable to use disinfectants before the discharge of such a sewage effluent?

A. I might have added that to my last answer as one of the reasons why sewage is sometimes disinfected.

Q. What reason?

A. If it is desired to make a body of water into which sewage is discharged entirely safe for bathing purposes, disinfection of the sewage effluent would be one method of removing the danger.

Q. In your investigation and studies of the testimony given in this present case, have you had occasion to review the report of Major Charles E. Woodruff, Major of the Medical Corps U. S. Army, made to the Adjutant-General Department of the East at Governors Island, with regard to the dangers of bathing in our harbor waters, and to the menace of the discharge from the Passaic Valley trunk sewer?

Mr. Riker: Is that one of the exhibits in the case?

Mr. O'Sullivan: No.

344 Mr. Riker: Objected to on the same ground as the last question is objected to, and on the further ground that it does not appear to have been in the case at all—this particular document.

Commissioner Maher: Note the objection of counsel for the defendants.

A. I don't remember of having read it.

Mr. O'Sullivan: Counsel for complainants would say that while this report in its entirety is not an exhibit, that it is embodied in the testimony itself of some of the witnesses which is a matter of record in this case.

Q. I will quote, and see if it accords with your opinion with regard to rendering bathing water safe in our harbor waters:

"On general hygienic principles it is not safe to swallow what has recently left the bowels of someone else, and as swimmers invariably take in a little of the water in which they swim, the soldiers taking swimming exercises are compelled to run a disgusting and dangerous risk. Even at present it is not safe for the soldiers to use the Harbor for bathing and swimming exercises, but in the conditions of an enormous increase of the sewage to be deposited at Robbins Reef, the risk

may be prohibitive and the efficiency of the Nation's defenses will be jeopardized to that extent."

Does that accord with your judgment on the discharge of sewage effluents from a large territory which has not been disinfected and into a body of waters that are used for bathing?

A. No, sir.

545 Q. You believe that there are no such dangers as Dr. Woodruff mentions there, from bathing?

A. I believe that there are dangers—possible dangers from bathing in water polluted with sewage, but I think that in his statement he has very greatly exaggerated these dangers.

Q. And you would not deem it necessary to disinfect the sewage effluent from which such dangers are apprehended, would you?

Mr. Riker: The question is objected to because of the indefiniteness of it, it not appearing whether such danger refers to this highly colored liquid of Dr. Woodruff or to the testimony of this witness.

Commissioner Maher: Note the objection of counsel for defendants.

A. No, sir.

Q. In sewage polluted waters, Mr. Whipple, and where the sewage is undergoing putrefactive changes, what organisms are first developed in the usual way?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. First those which are capable of obtaining their oxy-
546 gen supply from the dissolved oxygen in the sewage or water, and after that dissolved oxygen has been exhausted, the organisms, which are capable of obtaining their oxygen from the organic matter or from the mineral matter which may be present.

Q. At what stage in the putrefaction of sewage which has been discharged into the harbor waters, are the chlorophyll bearing protococci developed?

A. At almost any stage when oxygen is present.

Q. In your examination of the waters of the Passaic River, Mr. Whipple, you discovered many of those organisms that are developed during advanced putrefaction conditions, did you not?

Mr. Riker: Objected to as not cross examination.

Commissioner Maher: Note the objection of counsel for defendants.

A. I should say not; I don't remember that they developed in the places where the putrefaction conditions were present.

Q. You made investigations and analyses the micro-organisms from samples taken on June 19, 1906, did you not, from the Passaic River at Paterson?

A. I di[illegible] if the results are stated in the report; I don't recall

the circumstances; if I could have the book, I would be
547 very glad to say. (Witness shown book.) May I have the question.

Q. (Last question repeated).

A. Yes, sir.

Q. And those organisms are specifically named in table 4 at page 30 of the report of Hazen and Whipple to the City of Paterson, made in 1906, on sewage disposal?

A. Yes, sir.

Q. How many of the enumerated micro-organisms in that table did you find in the samples of water which you examined from New York Harbor in 1919?

A. Only one or two of them.

Q. Will you name those that you found?

A. As I remember, we found one known as synedra.

Q. Is that organism peculiar to sewage polluted waters?

A. No, sir.

Q. Did you make any examination of either the trade wastes or the sewages that were to be contributed to the Passaic Valley trunk sewer at any time between 1906 to the present time?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for the defendants.

A. I made a study of both the sewage and the trade wastes in the City of Paterson in connection with the report of Mr.
548 Hazen to the City of Paterson.

Q. Did you find a large percentage of colloidal matters in the trade wastes of the City of Paterson?

A. I think so, as I look back upon it.

Q. Are those forms of trade wastes difficult to treat and to eliminate the colloidalisms?

A. Some of them are; it depends largely upon what the colloidal substances are.

Q. What were they in your examination of the trade wastes of Paterson?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I don't remember, as that investigation was made many years ago.

Q. Have you compared, Mr. Whipple, any of the ogygen determinations made in New York Harbor waters in 1909 and 1911, with a view of determining whether or not the oxygen content had been depleted in those waters during those two years?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. Yes, sir.

Q. And what did you find?

549 A. I cannot make a statement on that without going into a great deal of detail. My general impression has been that in certain parts of the Harbor there has been a lessening of the amount of oxygen present. On other parts of the Harbor, no particular or important changes occurred.

Q. Does that indicate to you that the diffusion was not very uniform in the Harbor waters?

A. I think that that is a fact, that the diffusion is not uniform.

Redirect examination.

By Mr. Riker:

Q. Mr. Whipple, the ordinary milk of common use, has that a large number of bacteria in it?

A. Very frequently.

Q. Do you know what the element of safety is taken to be per cubic centimeter?

A. Oh, yes, variously stated; some health authorities will say 100,000 bacteria per cubic centimeter; others say one-half million, others say something else.

Q. Now you have been asked about the prevalence of typhoid fever in the Passaic Valley water, which may be said to be epidemic as a disease in the Passaic Valley and the City of Newark; how does it compare in that respect with the City of New York per capita, do you know?

550 A. I don't recall what the comparative rates are at the present time, but I think it may be safely said that in all of the cities of the Passaic Valley District and in New York, the death rates from typhoid fever have been steadily decreasing during the past ten years.

Q. You have no knowledge, then, as to the comparative numbers in New York and Passaic Valley?

A. I have sudied the figures for New — City, but I do not recall of having them for the cities in the Passaic Valley.

Q. Are there numerous cases in New York City?

A. There are still numerous cases, considering the size of the city, but the death rate from typhoid fever, the case rate, has steadily decreased in recent years.

Q. Do you know whether there has been any methods or treatment applied to the sewage of New York City to remove the typhoid bacillus from the sewage?

A. As far as I know, there has not been.

Q. I think you testified that the population was estimated by you somewhere near 6,000,000?

A. Yes, sir.

Q. That is discharging into the waters of New York Bay or the surrounding waters, the Hudson River and East River and Harlem?

A. Yes.

551 Q. So far as you know, you are able to say that the number of pathogenic germs discharged per capita from New York population is less than the number discharged from the Passaic Valley population?

A. I cannot answer that without knowing something more than I know about the relative rates, but from the fact that the New York population is so much larger, I should say that it would be more for New York City.

Q. If the discharge of sewage into the water of New York Bay from the Passaic Valley Sewage works would render it unfit for bathing, have you any question that the waters are rendered unfit for bathing by reason of the discharge of New York Sewage?

A. No, sir.

Q. Mr. Whipple, in cross-examination it appeared that there are some observations or samplings of—there were some samplings of water in 1909 that were not included in Exhibit 8, from stations from which water was taken for sampling in 1919?

A. Yes, sir.

Q. Will you turn to a table, if you have one, which shows those samples and the stations from which they were taken?

A. Yes, sir.

Q. Have you it before you?

552 A. Yes, sir.

Q. Who prepared it?

A. I did.

Q. And when were the samples taken?

A. On November 4, 1909.

Q. The next day after these that are shown in Exhibit 8?

A. Yes, sir, it was a continuation of the same investigation.

Q. And the stations cover some of the stations that appear in the Exhibit 9 in this case?

A. Yes, sir, the station marked number AA being the same as station A in the other investigation, and the station marked number CC being the same as the station C in the other investigation.

Q. And the columns on that table show the same results as in Exhibits D9 and D8, I mean the same character?

Mr. O'Sullivan: I object and move that it be stricken out.

A. Yes.

Mr. O'Sullivan: This is part of your direct examination.

Mr. Riker: You brought it out on cross-examination, and this is redirect.

Mr. O'Sullivan: I did not bring out anything of the kind.

553 Commissioner Maher: Note the objection of counsel for complainants and defendants.

Q. I hand you a blue print and ask you whether that is a correct copy of blue printing of the table before you?

A. Yes, sir.

Mr. Riker: I offer that in evidence and ask that it be marked.

Mr. O'Sullivan: I object on re-direct. This is part of your direct case. I have shortened my cross-examination in order to permit this witness to catch a train. Now, you are reopening the case and introducing new evidence which is part of your main case, and my objection is based on that ground.

Mr. Riker: I ask that it be marked.

Commissioner Maher: Note the statement of counsel for complainant.

(Blue print referred to marked Defendants' Exhibit No. 8A.)

New York Harbor, Nov. 4, 1909.

Station.	Depth.	Time.	Temp.	Color.	Turbidity.	Chlorine, PPM.	Dissolved oxygen. PPM.	Dissolved oxygen. CcpL.	Dissolved oxygen. Sat. PPM.	% Sat.	% Sea water.	% Land water.
AA	Surf.	1.30	10.7	5	3	14,900	5.80	4.12	9.41	63.0	82.8	17.2
AA	30'	1.40	10.7	4	4	15,100	5.91	4.13	9.40	63.0	83.9	16.1
N	Surf.	2.45	10.8	4	5	15,100	5.87	4.11	9.38	63.0	83.9	16.1
N	24'	2.48	10.8	2	10	15,200	5.88	4.12	9.37	63.0	84.4	15.6
O	Surf.	3.13	10.7	6	5	14,800	5.72	4.00	9.43	61.0	82.2	17.8
O	19'	3.20	10.7	5	4	14,700	5.58	3.90	9.43	59.6	81.7	18.3
P	Surf.	3.37	11.0	8	3	15,100	5.08	3.55	9.34	54.5	83.9	16.1
P	20'	3.45	11.0	6	3	14,500	5.06	3.54	9.40	54.0	80.6	19.4
Q	Surf.	4.08	10.7	8	3	14,900	5.75	4.02	9.41	61.0	82.8	17.2
Q	22'	4.12	10.7	7	6	15,000	5.75	4.02	9.41	81.0	83.3	16.7
CC	Surf.	4.30	10.4	8	5	15,300	7.52	5.26	9.43	80.0	85.0	15.0

Dissolved Oxygen.

New York Harbor, Nov. 5, 1909.

AAA	Surf.	10.00	10.0	7	4	13,200	6.32	4.42	9.76	65.0	73.3	26.7
AAA	Surf.	10.05	11.1	13	4	14,300	5.70	3.99	9.41	61.0	79.4	20.6

JAMES D. MAHER,
Commissioner.

555 Q. Referring now to Defendants' Exhibit 8, by which it appears that on May 3, 1919, high tide at Governor's Island at 11:37 a. m. I ask you whether the samples taken were all taken on flood tide?

A. Not if by flood tide we include the time between low water and high water. I cannot say whether they were all taken on the inflowing current, but my impression is that a few of them were taken when the current was flowing outward. As for example, those at Station J were taken at three o'clock in the afternoon, or about three and one-half hours after high water at Governor's Island.

Q. Both of those samples are taken, one at 3 and the other at 3:10?

A. Yes.

Q. Samples at Station L, taken at 2:50 was that taken on the flood or——

A. Probably not.

Q. And the samples at Station K, 2.20 and 2.30?

A. Probably not.

Recross-examination.

By Mr. O'Sullivan:

Q. What was the condition of the tide when you took the samples marked Defendants' Exhibit 8A on November 4, 1909?

A. I should say that most of them were taken on what would be called ebb tide, that is, the time between high water and low
556 water.

Q. When was high water on that day?

A. I have no record of it here, but presumably about one hour later than it was November 3.

Q. On what do you base that presumption?

A. On my general knowledge that the tides are about one hour later each day than the day before.

Q. With what stations on Exhibits 8 and 9 do the stations on Defendants' Exhibit 8A correspond?

A. To the stations which bear the corresponding letters.

Q. All the determinations recorded in Defendants' Exhibit 8A were made on November 4, 1909, under the same conditions as those recorded in the tabulations marked Defendants' Exhibit No. 8 and Defendants' Exhibit No. 9?

A. All except two at the bottom of the page, which refer to samples collected and acquired November 5, 1909, at Station marked AAA.

Q. Were the samples taken and recorded on Defendants' Exhibit 8A at the stations marked AAA identical as far as the station location is concerned with those in the same exhibit marked AA?

A. As well as could be told, by an approximate location; they were intended to be the same.

Q. What was the condition of the tide on November 5,
557 1909?

A. It was probably high at Governor's Island at about half past one.

Q. And what tide were those samples taken on, on November 5, 1909, on an incoming flood water or an outgoing ebb water?

A. Probably on an incoming water.

Q. All the samples taken at Stations AA and AAA in Defendants' Exhibit 8A are lower in oxygen content than those taken at Station A on May 3, 1919, are they not?

A. Yes, sir.

Q. How do you account for that increase in the oxygen content for those stations in the ten years?

A. I don't pretend to account for it; I have already suggested certain possible explanations, one of which was the fact that there was less land water present in the water at that place in 1909 than in 1919, and another, the fact that they were collected at different seasons of the year.

Q. You have no definite record of the tidal conditions for November 4, 1909, and for November 5, 1909?

A. No, sir.

Q. And the tidal conditions for November 3, 1909, you have no definite record of, have you?

558 A. I find that I have here a statement of the time of high water on November 4, 1909; according to the Nautical Almanac, high water occurred at Governor's Island at 1.24 P. M. and low water occurred at 7.57 P. M. I haven't a record of the tidal conditions on November 5.

Q. Nor for November 3, 1909?

A. Yes, sir, I stated that earlier in my testimony.

Q. That, you said then, you got from a newspaper.

A. No, sir, this was taken from a Nautical Almanac.

Q. On November 3, 1909?

A. Yes, sir, and November 4, 1909.

Q. Then you have no record for November 5, 1909?

A. Not here, no, sir.

559 In the Supreme Court of the United States.

THE PEOPLE OF THE STATE OF NEW YORK, Complainants,

vs.

THE STATE OF NEW JERSEY and PASSAIC VALLEY SEWERAGE COMMISSIONERS, Defendants.

Transcript of Testimony Taken in the Above entitled Cause Before James D. Maher, Esq., Commissioner, Appointed by the Supreme Court of the United States, at Room 1540, Municipal Building, City of New York, on Monday, August 4th, 1919, at ten-thirty o'clock a. m.

Appearances:

For Complainants:
Charles D. Newton, Attorney-General of the State of New York.
William J. O'Sullivan, Solicitor and of Counsel.
Hon. Charles E. Hughes, Special Counsel.

For Defendants:
Thomas F. McCrann, Attorney-General of the State of New Jersey.
560 Adrian Riker, Counsel, Passaic Valley Sewerage Commissioners.
Robert H. McCarter, Special Counsel.

New York City, N. Y.,
August 4th, 1919, 10:30 a. m.

KENNETH ALLEN was called as a witness on behalf of the complainants, and after having been duly sworn, testified as follows:

Direct examination.

By Dr. O'Sullivan:

Q. What is your full name, Mr. Allen?
A. Kenneth Allen.
Q. What is your present position?
A. Sanitary Engineer to the Board of Estimate and Apportionment.
Q. What is your profession?
A. Civil engineer.
Q. Mr. Allen, will you state what training and educational equipment and degrees and societies that you are affiliated with with regard to your profession, as fully as you can.
A. 1876-7, draftsman, Boston Water Works—Sudbury Supply. A. Fteley, Chief Engineer.

1879, graduated Rensselaer Polytechnic Institute with degree of C. E. and took temporary work in office of Hiram F. Mills, Lawrence, Mass.

561 1879-83, Draftsman, Leveler, Transitman and Division Engineer (in charge of construction of three divisions) on Kansas City, St. Joseph and Council Bluffs Railroad, Missouri, Kansas & Texas Railroad, Atchison, Topeka & Santa Fe Railroad, and Pittsburg, McKeesport & Youghiogheny Railroad.

1883-6, Assistant Engineer, Philadelphia Water Department. Investigations for new supply under Rudolph Hering.

1886-88, in general practice in Kansas City, Missouri, (Breithaupt & Allen), and, during the last year, Superintendent of Construction in charge of all sewer, bridge and paving work under the City Engineer. During this period organized and was Secretary of Engineers Club of Kansas City; made preliminary surveys for Kansas City, Lawrence & Nebraska Railroad (324 miles); designed water works for Medicine Lodge, Kansas; constructed Greenleaf, Kansas, Water Works; reported on various water supply projects; installed sewerage and plumbing for the War Department at Fort Supply, Indian Territory.

1888, elected Member American Society Civil Engineers.

1890-3, made a topographical survey of the Connellsville Coke Region, about 170 square miles, for the H. C. Frick Coke Company, and reported on water supplies for the 25 or 30 mining towns of the Company.

562 1893-5, in charge, under Commissioner of Public Works, of sewer and paving work, Yonkers, New York, and until taken over by City of New York of certain sewers in Williamsbridge.

1895-9, in charge of investigations and preliminary plans and estimates for the sewerage and sewage disposal of the City of Baltimore; Mendes Cohen, President of Commission, R. Hering and S. M. Gray, Consulting Engineers.

1899-1902, in partnership with Nicholas S. Hill, Jr., and H. M. Quick in consulting practice at Baltimore, and later in New York. Reported on Water Works at Newport News and Hampton, Virginia, Blue Ridge Summit, Roland Park, and various suburbs of Baltimore, Md.; Kane, Pa., and Norwich, Conn. Reported on sewerage for Connellsville, Pa., and Rehoboth, Delaware. Constructed water works at Westminster and Laurel Maryland. Made valuations of Water Works and sewerage at New Berne, North Carolina. Water Works at Portsmouth, Suffolk and Berkley, Virginia, and on electric lighting at Laurel, Maryland. Made investigations for an artesian well supply for Charleston, South Carolina. Reported on water power at Relay, Maryland, and served as expert for Baltimore & Ohio Railroad in case involving the flooding of mills at Ellicott, Maryland.

1902-5, Engineer and Superintendent of Water Department, Atlantic City, New Jersey. Installed system of artesian wells,
563 new wood stave supply and conduit and a concrete dam, extended system of metering, conducted engine and boiler tests, etc. Reported on high pressure fire system to Board of Trade.

Reported on system of water supply for City of Passaic, New Jersey. Served on Arbitration Board in settlement of Water Works Case, Ephrata, Pa., Emil Kuichling, Chairman. Consulted by Canadian Pacific Railway Company in settlement of dispute with contractor on pipe-laying at Montreal.

1905-8, Division Engineer, Baltimore Sewerage Commission in charge of construction of low level intercepters along the waterfront. Reported on the condition and value of work done on the Yadkin River dam and canal at Whitney, North Carolina, to the T. A. Gillespie Company.

1908-14, Engineer, Metropolitan Sewerage Commission of New York, conducting: *a*. Studies of the Tides and Currents of New York Harbor, including extensive float observations. *b*. Investigations of the admixture of sea water with fresh water in New York Harbor, including salinity observations taken three times a day at eleven stations for over a year. *c*. Experiments on the diffusion of sewage in water. *d*. Experiments to demonstrate the pollution of public bath houses by sewage. *e*. Inspections of the sewers of Manhattan and of the sewerage systems and outlets of the Metro-
564 politan District. *f*. Inspections and reports on the various miscellaneous sources of pollution of New York Harbor with the financial loss entailed. *g*. Studies of the population of New York and the Metropolitan District and of the resulting volumes of sewage. *h*. Studies of the necessity for improved methods of sewage disposal for New York including various plans and estimates for interception and treatment. *i*. Studies of the capacity of Jamaica Bay to receive crude sewage.

1913—Made trip of inspection of sewage disposal plants in Scotland, England, France, Germany and Holland.

1914—Reported on system of sewage disposal for Hyndman, Pennsylvania. Consulting engineer on system of sewage disposal for Bellwood, Pennsylvania.

1915 to date—Engineer Bureau of Sewer Plan and then Sanitary Engineer, Board of Estimate and Apportionment of New York City; projecting and passing on plans for main drainage and sewage disposal, carrying on dissolved oxygen determination in New York Harbor, etc. Special investigations have comprised:

Test of the Electrolytic plant at Elmhurst, Borough of Queens; Report on the Sewerage and Sewage Disposal for the territory tributary to Jamaica Bay; Co-operation with the Sewer Bureau of Rich-
mond in planning various experiments on sewage treatment;
565 investigation and report on the character of the sewerages of Manhattan.

1918—For two months District Engineer, U. S. Housing Corporation in charge of housing developments at Alton, Illinois; Cincinnati, Ohio; Cleveland, Ohio; Hammond, Indiana; Lyle, Tennessee; Muskegon, Michigan; Portsmouth, Ohio; South Bend, Indiana. Consulted on design of new type of sewage screen.

Member of: American Society Civil Engineers; American Public Health Association (Chairman Commission on Sewerage and Sewage Disposal); Municipal Engineers of New York (Chairman Com-

mittee on Rainfall and Run-Off); Associate, Rensselaer Society of Engineers.

Author of: "Sewage Sludge" (McGraw-Hill Co., 1913).

"The Fine Screening of Sewage" (Trans. American Society Civil Engineers, 1915).

"The Pressing of Sewage Sludge" (Trans. American Municipal Improvements, 1917-1918).

"The Pollution of New York Harbor and Its Remedy" (Proc. Conn. Society Civil Engineers, 1916).

"The Transmission of Typhoid by Sewage Polluted Oysters (Trans. American Public Health Association, 1899).

"The Diffusion of Sewage" (Trans. American Public Health Association, 1916).

566 "Dissolved Oxygen as an Index to the Pollution of New York Harbor" (American Society for the Advancement of Science).

"The Use of the Salinometer in Studies of Sewage Disposal" (Journal Association of Engineering Societies, 1911).

"The Sanitary Protection of Water Supplies" (Journal Franklin Institute, 1905).

Q. As an engineer, were you connected with the Metropolitan Sewerage Commission?

A. I was.

Q. And in line with your duty as engineer in the Metropolitan Sewerage Commission, did you familiarize yourself with the facts relative to the volume of sewage discharged into the harbor waters of New York?

A. Yes.

Q. Mr. Allen, are you familiar with the population figures for the Greater City of New York, and for its various Boroughs?

A. I am familiar with the figures for Greater New York and its various Boroughs, and I made a study of those for the surrounding territory with the Metropolitan Sewerage Commission. Those relating to New Jersey I have not made any special study of, since that time.

Q. Will you state what the population figures and estimates were for the Greater City, and for the riparian cities in the State of New Jersey.

567 By Mr. Riker:

Q. May I ask him a question there? When were those studies made?

A. Those studies were made this month for New York City, and for New Jersey we made forecasts for the Sewerage Commission up to 1960, and I have the 1915 populations for certain New Jersey cities.

By Dr. O'Sullivan:

Q. Will you state what those figures are, Mr. Allen?

A. I make the population, the present population, of Greater New York, 6,466,000 persons, and I estimate that by 1960, the population will be 15,976,000. This is the table:

Bureau of Public Improvements.

City of New York.

Population of New York City..... File.....1.5.N.Y.
..... Acc.....2294.....
.....Computer..K. A. ..... From..... To.....
Made in connection with.....Checker..... Date.....July 29, 1919.

Contributory in 1919 to—	Manhattan.	Bronx	Queens.	Brooklyn.	Richmond.	Total.
Hudson	1,138,000	6,000	.....	.....	.....	1,144,000
Harlem	700,000	444,000	.....	.....	.....	1,144,000
Upper E. R.	.....	350,000	170,000	.....	.....	520,000
Lower E. R.	962,000	.....	188,000	1,000,000	.....	2,150,000
Upper Bay	.....	.....	.....	770,000	18,000	788,000
Kill V. K.	.....	.....	.....	.....	51,000	51,000
Arthur K.	.....	.....	.....	.....	18,000	18,000
Jamaica B.	.....	.....	202,000	404,000	.....	606,000
Lower B.	.....	.....	.....	26,000	19,000	45,000
Long I. S.	.....	.....	.....	.....	.....	.....
Total	2,800,000	800,000	560,000	2,200,000	106,000	6,466,000

1900 to—						
Hudson	1,589,000	53,000	.....	.....	.....	1,642,000
Harlem	743,000	1,233,000	.....	.....	.....	1,976,000
Upper E. R.	.....	1,297,000	1,076,000	.....	.....	2,373,000
Lower E. R.	894,000	.....	961,000	2,460,000	.....	4,315,000
Upper Bay	.....	.....	.....	2,610,000	74,000	2,684,000
Kill V. K.	.....	.....	.....	.....	142,000	142,000
Arthur K.	.....	.....	.....	.....	74,000	74,000
Jamaica B.	.....	.....	1,313,000	1,216,000	.....	2,529,000
Lower B.	.....	.....	.....	114,000	110,000	224,000
Long I. S.	.....	17,000	.....	.....	.....	17,000
Total	3,226,000	2,600,000	3,350,000	6,400,000	400,000	15,976,000

569 The Witness (continuing): In that connection, the population studies were made of the different boroughs and maps prepared showing a dot for each 500,000 or 1,000, as the case may be, population in 1916. This is the map of Manhattan. In this case, each dot represents 500 persons. The full dots represent the population in 1910, according to the 1910 census.

Q. The white?

A. The white dots. And the open dots, the circles, show the additional population which is estimated up to the year 1960. This is the resident population and does not show the floating population. You see down here in the Wall Street district there is hardly any population—there, and up Broadway.

Q. What is the approximate estimate of the floating population of the lower end of Manhattan, Manhattan in general?

A. I can not tell that.

Q. Approximately?

A. My impression is it is three-quarters of a million a day, but I would not like to be too sure of that.

Q. Varying between what, half a million and three-quarters of a million?

A. Well, I should say between half a million and a million. I imagine there are days when it will reach a million.

Dr. O'Sullivan: I offer this plotting of the population with
570 a view to showing its density and the areas in which it is most dense, as to the population in Manhattan, and I ask that it be marked Complainants' Exhibit No. 219.

By Mr. Riker:

Q. Who prepared this chart?

A. It was prepared by a draftsman under my direction.

Q. Who located the solid white dots?

A. Those were located by the Metropolitan Sewerage Commission, by taking the Congressional districts in the borough, the population of those districts, and apportioning the dots in each district that way.

Q. You say it was done by the Metropolitan Sewerage Commission?

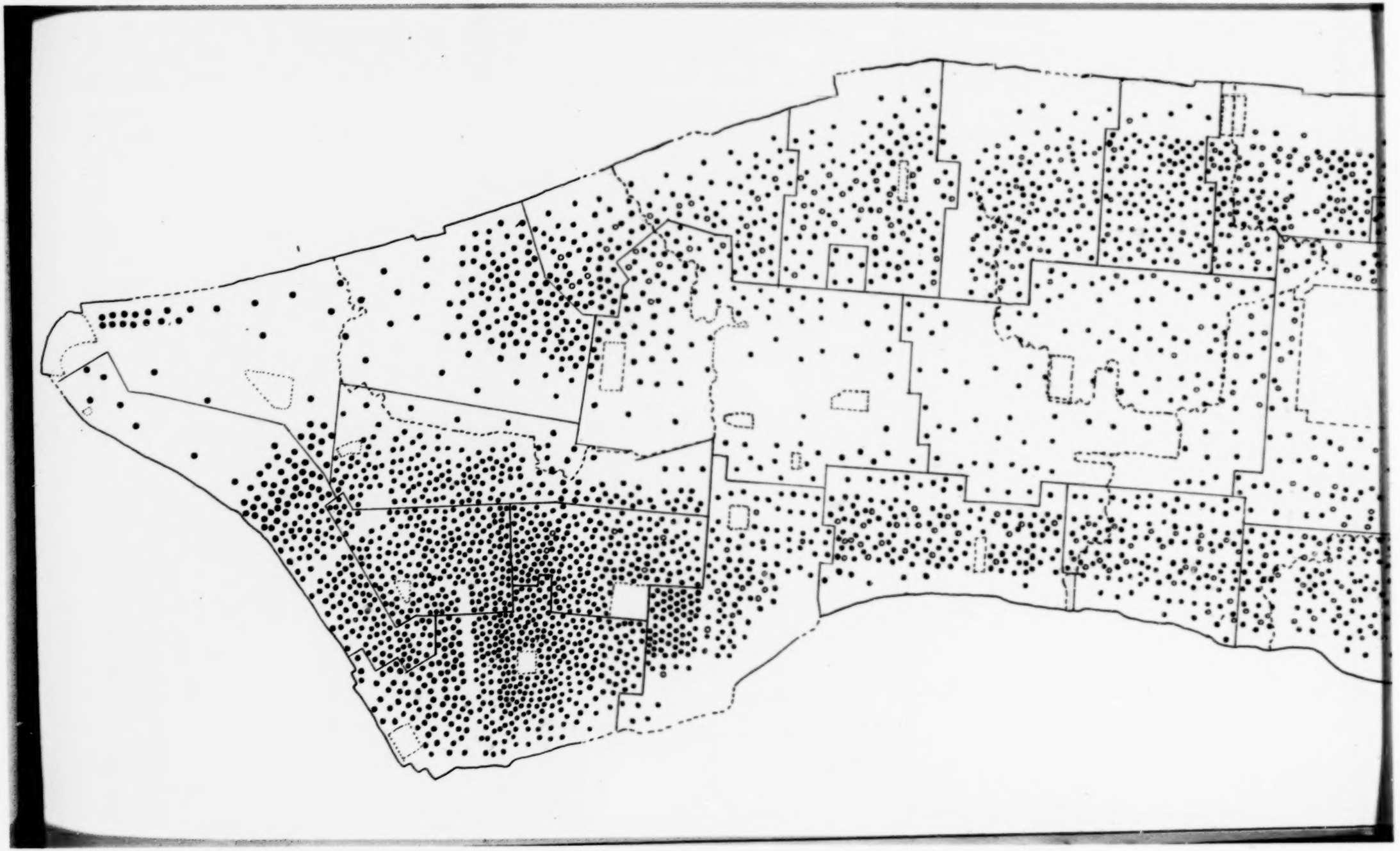
A. Not personally; it was done under my direction.

Q. What part did you have in doing it?

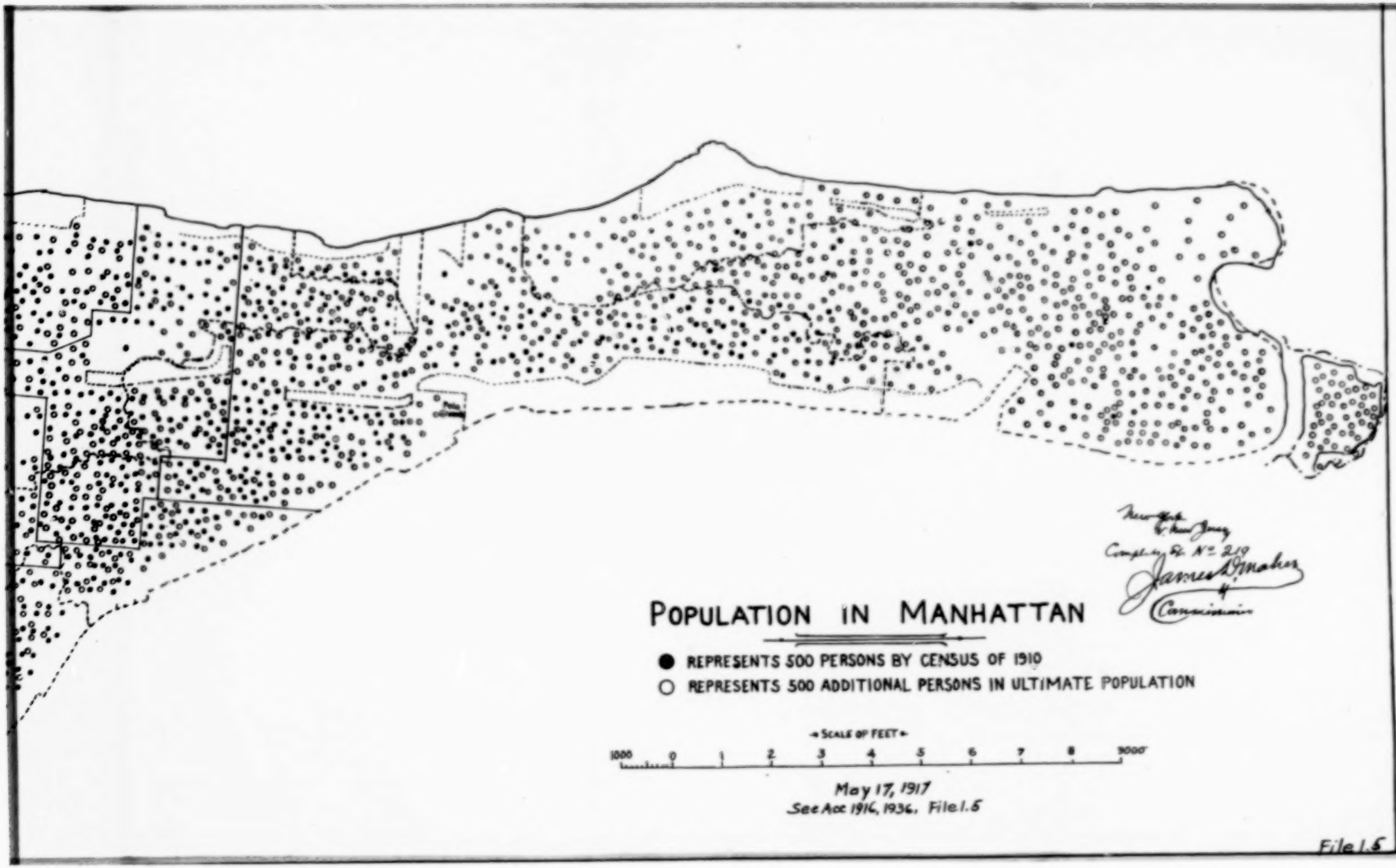
A. In revising and going over the distribution. For instance, if one of the districts covered a certain area, the distribution of those dots in that area would have to be according to judgment, and that would be reviewed—If there was a park here, and the draftsman put a dot in the park, it would have to be taken out from inside the park, or anything of that sort.

Q. What extension of area does each one of these solid
571 white dots represent, Mr. Allen?

A. That does not represent any particular area. It represents a population of 500. For instance, if this district here (indicating)——



Polo


POPULATION IN MANHATTAN
● REPRESENTS 500 PERSONS BY CENSUS OF 1910
○ REPRESENTS 500 ADDITIONAL PERSONS IN ULTIMATE POPULATION
SCALE OF FEET
1000 0 1 2 3 4 5 6 7 8 9000
May 17, 1917
See Acc 1916, 1936, File 1.5
File 1.5

Q. Pointing to what?

A. If this district, for instance, had a population which, divided by 500, would make 45 dots, those dots were placed in there by judgment, and of course I do not know that each dot is in the exact place as it should be, but the right number is in each district.

Q. So that practically it is another way of putting figures in?

A. That is all.

Q. And could just about as well in each one of those districts be indicated by putting in the figures of the population?

A. You would not have the distribution quite as close as you could get it if you had been over the ground and knew there was a particular congestion in this locality, and more of the dots should be thrown over in that part of the area.

Q. In determining the congested parts, what did you do with regard to them?

A. Nothing in particular, except to use my knowledge of the ground that I have. I did not go over the ground for that purpose.

Q. Then is it not a fact that this chart, so far as it goes, is simply a graphic illustration of the Population of Greater New York, divided up into Assembly Districts?

A. Yes, that is all.

572 (The paper was marked Complainants' Exhibit No. 219.)

(Here follows chart marked page 572a.)

Q. And the solid white dots there are the populations as shown by what census?

A. 1910.

Q. 1910?

A. Yes.

Q. And the circles represent a guess as to what the population would be in 1960?

A. They are an estimate. I would hardly call it a guess. We made as close an estimate as we could, but, of course, these vary.

Q. Will you state what the basis of your estimate for 1960 was?

A. Yes. The past population was plotted in curves, and the curves extended, to the best of my judgment.

Q. What assumptions did you make in extending the curves?

A. I do not know that I made any particular assumption, but those curves were then referred to the consulting engineers of the different boroughs of New York who, at that time, constituted what was known as the Administrative Committee of the Bureau of Sewer Plan, of which I was engineer. Mr. Nelson P. Lewis was the Chairman of that Committee. That Committee went over my figures, and the final conclusion was that sixteen million would be the probable population of New York in 1960, and the curves for the different boroughs were then adjusted to that total.

Q. And you adopted that estimate, and had the circles put
573 in accordance therewith?

A. Yes.

Q. And I suppose the circles are distributed in the same way as the dots are, merely in a graphic way setting out a certain population in the different Assembly Districts reached by this method of estimation for 1960?

A. Yes.

Dr. O'Sullivan: He has just visualized. You could do it better that way than by mere figures for convenience.

Mr. Riker: I understand. The offer is objected to on the ground that it does not represent the understanding and the personal work of the witness.

The Commissioner: The objection of counsel for the defendants will be noted.

Dr. O'Sullivan: Please go on.

The Witness: This is a similar map of Brooklyn, but based on the 1915 population, which we worked out in the same way.

By Dr. O'Sullivan:

Q. And it is for the Borough of Brooklyn?

A. The Borough of Brooklyn, yes. In this map every dot represents 1,000 population instead of 500.

Dr. O'Sullivan: I offer the visualized plotting of population for the Borough of Brooklyn as described by this witness, based on the

population for 1915 and the estimate for populations that will
574 be accommodated in 1960. I offer it in evidence and ask that it be marked Complainants' Exhibit No. 220.

By Mr. Riker:

Q. Mr. Allen, I suppose you followed the same methods in making up this chart that you did in the matter of the Borough of Manhattan?

A. Yes.

Q. And your part in the preparation of this chart was the same as in the other, substantially the same?

A. Yes.

Q. And so far as the circles are concerned, the method of estimating the population in 1960 was the same as in the Borough of Manhattan?

A. Yes.

Q. You do not mean to be understood, do you, that there is any accuracy in the matter of location of thousands of population by these solid dots?

A. Those for 1915, are, as I say, the right number in the district. No—there is no accuracy as to the exact position of the dot.

Q. How did you come to adopt this method, Mr. Allen?

A. Well, it is a standard method of making studies of that kind, and it is perfectly convenient for our use, because when we want to study a certain drainage area, we can put a tracing over any area and count the dots in it, which will give the probable future population. That makes it more convenient for our use than figures.

Q. Where you have the Assembly Districts which are after all the bases of your chart, would not the insertion of figures just
575 give the same results as this?

A. No, because the population would not coincide with the drainage area. Of course, we could take a certain proportional part of each Assembly District in the drainage area, and compute the population in that fraction, adding them together, when we would get the same result as by counting the dots, but with a good deal more labor.

Q. When you come to the location of the circles, Mr. Allen, how do you determine where the thousand populations in 1960, will be located approximately?

A. We had to use the best judgment we could; that is all that can be done.

Q. That is a guess, is it not?

A. It is an intelligent guess. You may call it a guess by a person that knows the trend of development, who has made a study of the trend of development. Of course, you cannot tell; a new subway line might make a material difference.

Q. And have you made in connection with it, a study of the actual land that was supposed to be the bases of these populations?

A. Yes.

Q. You did, personally?

A. I have been over the area pretty well, and others in the office have done so, and we used our combined judgment in apportioning the population.

Q. You do not mean to say, Mr. Allen, that you have personally studied every area where these circles or located?

576 A. Not at all, no.

Q. How many of them did you study

A. None with that end in view.

Q. Where did you get your information to have these located?

A. Those in the office used their combined judgment in apportioning them, all of which were more or less familiar with the Borough of Brooklyn.

Q. When you said, as you did a little while ago, that it was an intelligent guess, on what did you base your testimony that it was an intelligent guess?

A. Because we were more or less familiar with the development of Brooklyn, those in the office. The draftsman lived in Brooklyn and had lived there for a number of years; and we made a study of the proposed transit lines and took that into consideration, and the topography, and what appeared to us to be the probable development.

Q. Do you not think a more appropriate expression would be a more or less intelligent estimate?

A. No; I think intelligent estimate would express it.

Q. Can you state from your own knowledge what the proportion of these circles is to the solid dots on this chart?

A. That is shown on a print that I have prepared.

Q. You have. Can you state from recollection what it is?

A. No.

Q. You can not even approximate it from recollection?

577 A. I would rather not. I can tell the number of the total dots. No, I think I will refer to it and depend on the actual figures.

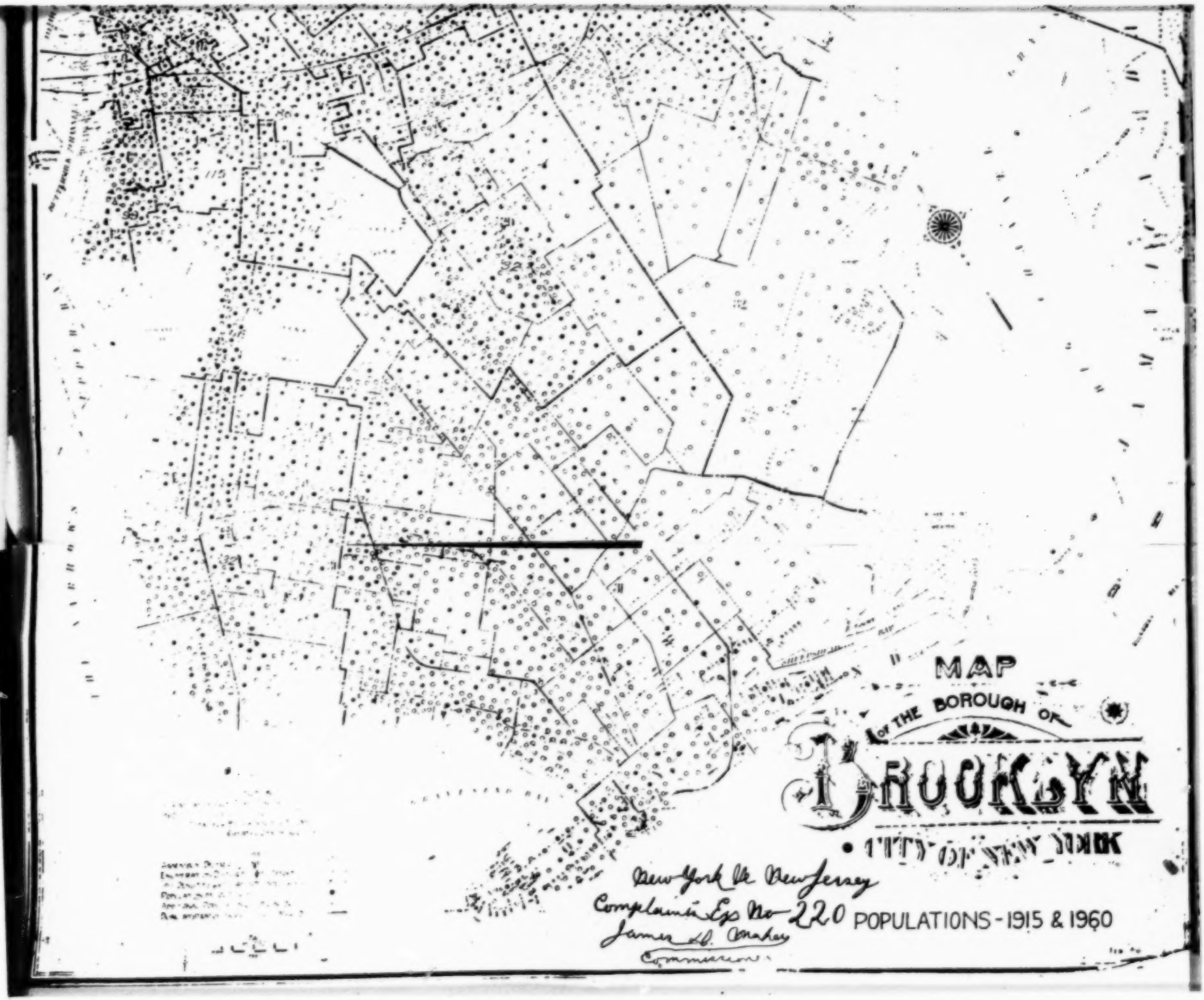
Mr. Riker: The offer is objected to on the same grounds as the last exhibit.

The Commissioner: The objection of counsel for defendants will be noted.

(The document was marked Complainants' Exhibit No. 220.)

The Witness: Here is a similar map of the population of the Bronx, except that this is only shown for the year 1960. The studies for that were preceded by a study made by the Bronx in submitting a sewer plan which gave their estimate for the 1940 population, and over all the area west of the Bronx River. With their familiarity with the Bronx, a good deal of weight was attached to their distribution, but we depended on our own judgment with regard to that east of the Bronx River. In this plotting a spot represents 1,000 population.

Dr. O'Sullivan: I offer in evidence the plotted—the approximation of population densities in the Borough of the Bronx for the year


MAP
OF THE BOROUGH OF
BROOKLYN
CITY OF NEW YORK
New York & New Jersey
Complainant's Exhibit No. 220
James A. Bradley
Commissioner
POPULATIONS - 1915 & 1960

1960, as testified to by this witness, and ask that it be marked Complainants' Exhibit No. 221.

By Mr. Riker:

Q. Mr. Allen, your part in the preparation of this chart, did not differ materially from the chart of Manhattan Borough did it?

A. No.

578 Q. And I think that you have just said this only represents an intelligent estimate for the year 1960?

A. That is what I said with regard to Manhattan. I would repeat, though, that in this Borough we had the advantage of distribution of population made by the Bureau of Sewers west of the Bronx River.

Q. This does not, however, purport to represent anything existing at the present time, does it?

A. No.

Q. And the intelligent estimate was based upon what factors, Mr. Allen?

A. It was based on the census figures for—I won't be sure—1910 or 1915.

Q. Any other factor?

A. The past growth of the Bronx and the total for 1960, which, as I said, have been reviewed by the Consulting Engineers of the different boroughs, and approved.

Q. What was it that was determined for the year 1940, in this connection?

A. That was a distribution of population on the different small drainage areas, that was made by the Bureau of Sewers of the Bronx. They were getting out a comprehensive plan on which they showed these populations of 1940, and that served as a guide to us in distributing the population for 1960.

Q. Now, when you say "us," who were concerned in this?

A. The offices of the Board of Estimate and Apportion-

579 ment of the City of New York.

Q. What part did you have in it?

A. I had charge of that part of the work.

Q. The plotting of it?

A. Yes.

Q. Did you have charge of anything else in connection with it except the plotting?

A. Yes; the distribution, the whole preparation of that map.

Q. But the location of the dots on this map was determined by someone else, was it not?

A. The location, unless there was some reason why I should change it, was determined by the man who did the plotting.

Q. Who was that?

A. I think it was I. W. Foster, draftsman.

Q. And where did he get the data from which to make his plotting?

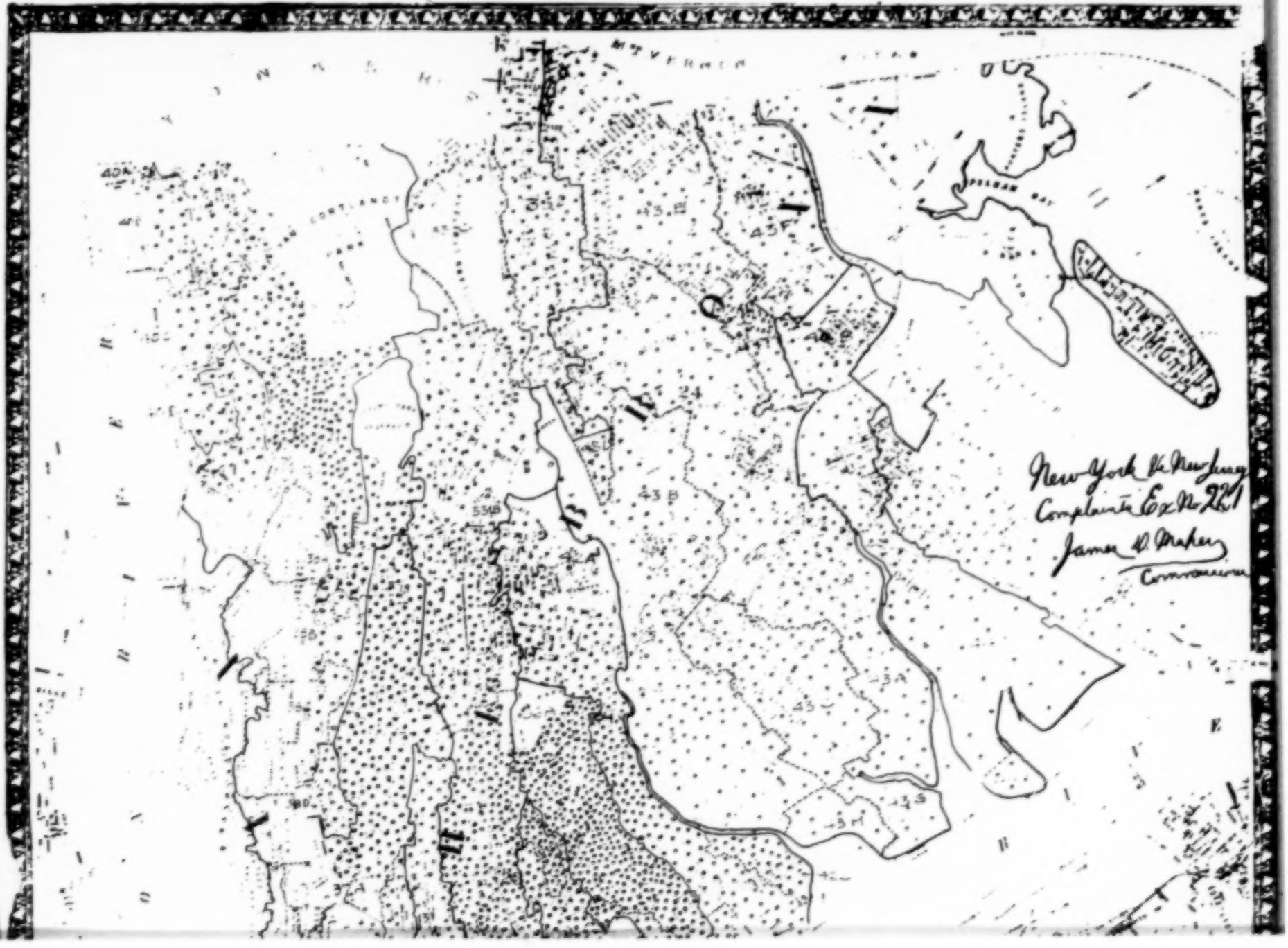
A. The same source.

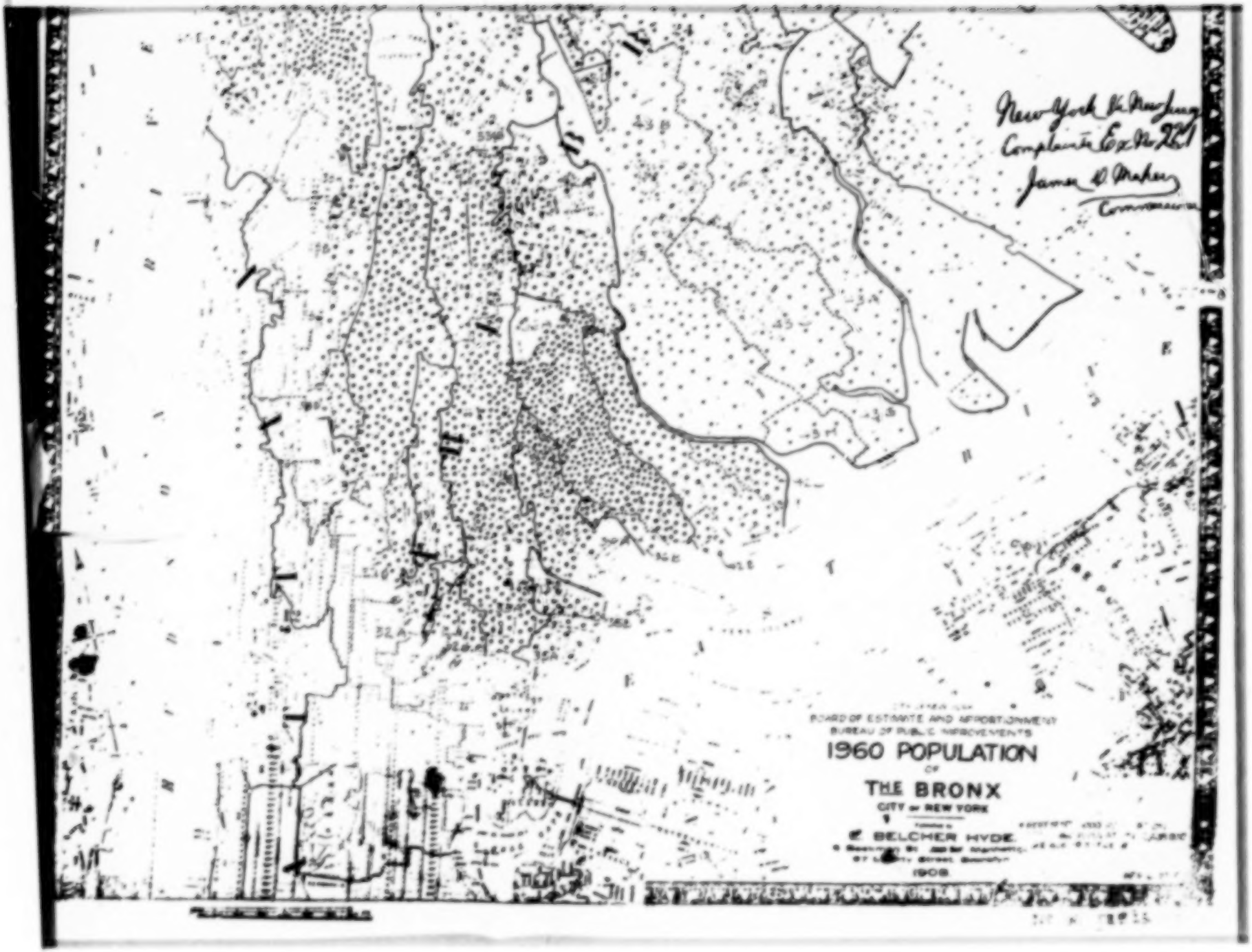
Q. What was that?
A. The census. The total figures for the Bronx which had been approved by the Consulting Engineers and this map of the Borough showing the distribution west of the Bronx River.
Q. Does this map represent your judgment, or the combined judgment?
A. It represents my judgment.
Q. Based upon the combined judgment of some other people, does it not?
A. It does.
Q. Not your independent judgment?
A. It does, altogether.
Q. Did not you rely upon these other people?
580 A. To a certain extent.

By Mr. Riker: The same objection as to the last exhibit.
The Commissioner: The same ruling. The objection of counsel for the defendants is noted.

(Paper received and marked Complainants' Exhibit No. 221.)

(Here follows map marked page 580*a*.)


New York & New Jersey
Complaints Ex No 221
James D. Maher
Commissioner
MT VERNON
CORTLANDT
PARK
PELHAM BAY
43 B
43 F
43 A
43 C
43 H
43 S
33 B
24


New York Vs New Jersey
Complaints Ex No 251
James D. Maher
Commissioner
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS
1960 POPULATION
OF
THE BRONX
CITY OF NEW YORK
E. BELCHER HYDE
1908

By Dr. O'Sullivan:

Q. Mr. Allen, what was your object in plotting, as you have just described, on these maps that have just been marked as exhibits, the density of population, and the areas where the density was expected to be greatest?

A. So that we could design any sewers in that region so that they would be applicable for the service called upon, without costing too much and without being extravagant in size.

Q. Have you got like plottings for the Boroughs of Queens and Richmond?

A. I have.

Q. Are they here? A. No. I have some figures for some of the New Jersey cities.

Q. We will come to that later. What part of the population of the City of New York is contributory to New York Bay and the East River and the Harlem River?

A. They are referred to in the populations which I have already read off.

Q. Now, on the New Jersey side of the Hudson River and on New York Bay, what population contributes sewage to these waters that are riparian to these waters, in the State of New Jersey?

581 A. I have the populations of the three largest cities. It is estimated for this year, and estimated by the Metropolitan Sewage Commission for 1940, merely as a guide. Bayonne, 79,300 for 1917, 157,000 for 1940. Jersey City, 291,000 for 1909; and 396,000 for 1940. Hoboken, 71,600 for 1919, 92,500 for 1940.

Q. Have you calculated the percentages of the six millions of people that you have stated to be the population of the City of New York that contribute sewage to these waters?

A. I have estimated the populations tributary to the different bodies of water for 1919 and for 1960, from New York City (handing paper). The upper table shows the 1919 volume of sewage that goes from each Borough into the main bodies of water. For instance, in Manhattan it is estimated that 135,000,000 gallons a day are discharged into the Hudson River, 81,000,000 gallons into the Harlem River, and 112,000,000 gallons into the Lower East River, and then, at the other end of the table, from Richmond it is estimated that 2,000,000 gallons a day are discharged into the Upper Bay; 8,000,000 into the Kill Van Kull, 2,000,000 into the Arthur Kill, and 3,000,000 into the Lower Bay, and the totals for each Borough at the bottom are on the right-hand side, making 776,000,000 gallons daily.

By Mr. McCarter:

Q. Below is the estimate for 1960, the same way?

A. The same way. This is the table:

Bureau of Public Improvements.

City of New York.

Volume of Sewage—New York City..... File...2.2 N.Y...(6)..
..... Acc.....2295.....
.....Computer..K. A. ..... From..... To.....
Made in connection with.....Checker..... Date.....July 31, 1919.

Million Gallons per Day.

1919 to—	Manhattan.	Bronx	Queens.	Brooklyn.	Richmond.	Total.
Hudson	135	1	...	...	...	136
Harlem	81	52	...	...	...	133
Upper E. R.	...	52	25	...	...	77
Lower E. R.	112	...	25	97	...	234
Upper Bay	...	...	...	85	2	87
Kill Van K.	...	...	...	...	8	8
Arthur K.	...	...	...	...	2	2
Jamaica B.	...	...	30	62	...	92
Lower Bay	...	...	...	4	3	7
Long Id. Sd.	...	...	...	...	...	...
Total	328	105	80	248	15	776

Goes to—						
Hudson	203	7	...	...	...	210
Harlem	99	101	...	...	...	200
Upper E. R.	...	231	113	...	...	344
Lower E. R.	114	...	99	233	...	446
Upper Bay	...	...	...	253	8	261
Kill Van K.	...	...	...	...	17	17
Arthur K.	...	...	...	...	8	8
Jamaica B.	...	...	138	137	...	275
Lower Bay	...	...	...	13	13	26
Long Is. Sd.	...	2	...	...	...	2
Total	416	341	350	636	46	1,789

584 By Dr. O'Sullivan:

Q. What is the population of Yonkers, that contributes sewage and trade wastes to the Hudson River?

A. The estimates for 1919 are 107,400, and for 1940 was estimated by the Metropolitan Sewerage Commission as 193,500.

Q. Are there manufacturing plants in the City of Yonkers?

A. Yes.

Q. Have you made any study of the volume of sewage discharged into the Harbor waters of New York?

A. Yes. Those are included in my last answer.

Q. Have you made any studies of the tidal phenomena in New York Harbor waters?

A. I have.

Q. Will you state, giving the range of discharge of the tidal prisms and the other factors that have come to your knowledge through your studies and through your experiments?

A. The tidal ranges at certain important points may be mentioned as follows:

At Governors Island, the mean range is 4.4 feet, and the range during spring tides is 5.3 feet.

The range at Hell Gate Ferry—that is a location where there was formerly a ferry, I presume—is 5.1 feet, and the spring tide 6.1.

At Throgg's Neck the mean tidal range is 7.2 feet, and the spring tide 8.5 feet, showing, in general, a greater range during
585 spring tides of about one foot.

Q. Mr. Stearns in his testimony, made references to the tidal range in Boston Harbor. Do you know what the tidal range in Boston Harbor is?

A. The tidal range at the Navy Yard, Charlestown Navy Yard, which is at the inner end of the harbor, is 9.6 feet, at mean tides, and 10.9 feet during spring tides. The range at Boston Light, which is at the outer end of the harbor entrance to the harbor, is 9 feet, and during spring tide, 10.3 feet.

Q. Mr. Stearns in his testimony gave evidence relative to the discharges in volume of these waters. Do you know what they are?

Mr. McCarter: Boston or New York?

Q. Both.

A. I have not them at Boston. At New York, the ordinary ebb discharge at the Narrows is 12,773,000,000 cubic feet per tide. In dry weather this is cut down to 12,228,000,000 cubic feet per tide. The returning flood current brings in 11,490,000,000 cubic feet per tide ordinarily, and in dry weather, 12,035,000,000 cubic feet per tide. The difference showing the excess that passes out to the ocean amounts ordinarily to 1,282,000,000 cubic feet per tide, and only 193,000,000 cubic feet per tide in dry weather. The Hudson, at its mouth, discharges into the ebb tide 6,722,000,000 cubic
586 feet per tide. On the return flood, 5,635,000,000 cubic feet, coming back, making a difference of 1,087,000,000 cubic feet

per tide, which does not come back. The average tidal flow in the Kill van Kull is 1,595,000,000 cubic feet.

Q. Mr. Allen, have you graphically visualized the volumes of water as now testified to on the ebb and on the flood, in the areas that you have testified to, showing the volume in the harbor and the tidal prism?

A. I have. This diagram shows for each main body of the harbor —the tidal prism represented by this length of this line here shown in yellow, this being 1,000,000,000 cubic feet, and this line being 2,000,000,000 cubic feet, each little square represents 1,000,000,000 cubic feet. For instance, the tidal prism in the Upper Bay is about between 2,500 and 2,600 million cubic feet. Below that tidal prism, that is, between mean high tide and mean low tide, the volume of the Upper Bay is illustrated by this length here, which is just short——

Q. One minute. When you say "this length here", describe whether it is in white or red or yellow?

A. This length is in white, and represents the volume of the Upper Bay, which is shown to be a little less than 13,000 million cubic feet. Turning to Newark Bay, the tidal prism is seen to be a little over 1,000,000,000 cubic feet, while the volume below the tidal prism is shown to be a little over 1,500,000,000 cubic feet.

587 The point of particular interest in this diagram is the relation between these two sets of figures. On the right-hand side shown outlined in red, are the percentages of the tidal prism to the volume below mean low water, showing that in the Upper Bay, for instance, the tidal prism is a little less than 20 per cent of the volume of the Bay, while in Newark Bay it is over 69 per cent, nearly 70 per cent in the volume of the Bay; that is to say, from mean low water to mean high water, a volume equal to 70 per cent of the water in the Bay enters the Bay from the Kill van Kull, and from the Arthur Kill.

Dr. O'Sullivan: I offer in evidence this visualized diagram of the figures relating to the tidal phenomenon, to which this witness has just now testified, and ask that it be marked Complainants' Exhibit No. 222.

By Mr. Riker:

Q. What part did you have in the preparation of this chart, Mr. Allen?

A. I made that myself, the original.

Q. You put the actual figures on it, did you?

A. Yes.

Q. And then, of course, they were blue-printed?

A. Yes.

Q. Where did you get your data?

A. From the United States Coast and Geodetic Survey.

Q. This, then, is a graphic delineation by you of what is contained in the United States Geodetic——

588 A. Coast and Geodetic Survey.

Q. And it does not represent any independent work by you?

A. No.

Q. It is simply, as I have already said, a graphic——

A. I should say that those volumes and tidal prisms were prepared by the Metropolitan Sewerage Commission. To the best of my recollection, I had charge of that work, but I do not think I did it myself. I think it was done by one of the other men. The estimation of the volume of the Bay and the bodies of water and of the tidal prisms, I do not remember positively whether I did it myself or not.

Q. In what form did you have the data then?

A. We took the charts, the United States Coast & Geodetic Survey charts, and measured the areas and multiplied those areas by the tidal range given by the publications of the Coast Survey. That gave the tidal prism. And then, to find the volume of the Bay, we took the area at mean low tide, and the areas at different stages of the tide, as shown by the soundings which were on those charts, multiplying the average between the two levels by the depth, and adding those together to get the entire volume of each body of water.

Q. You say "we" did that?

A. Yes.

Q. Who were "we"?

A. The force of the Metropolitan Sewerage Commission.

589 Q. You did not do it?

A. I think I did, a good part of it, but I could not swear as to that.

Q. This is not a graphic delineation of anything that is in the United States Coast & Geodetic Survey, is it?

A. No.

Q. It is a graphic delineation made by you of the work done by the Metropolitan Sewerage Commission force in determining the tidal prisms, and the volume of the Bay below mean high water?

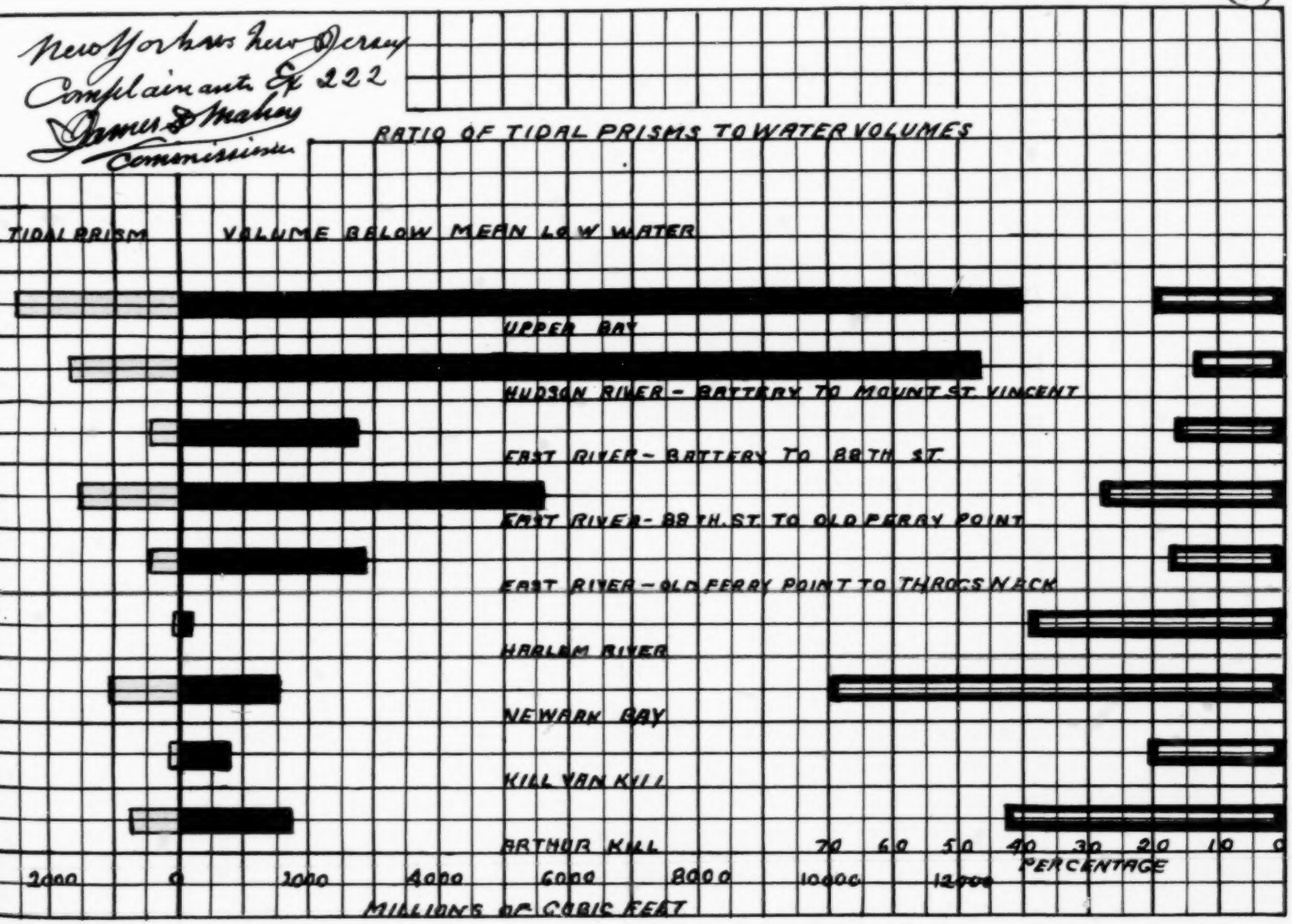
A. And the tidal prisms, yes.

Mr. Riker: No objection.

(Paper marked Complainants' Exhibit No. 222.)

(Here follows chart marked page 589*a*.)

New York vs New Jersey
Complainants Ex 222
James D Mahoney
Commissioner



By Dr. O'Sullivan:

Q. Did your studies extend to the velocities of the currents in the bodies of water that you have testified to, and if so, have you prepared reports or diagrams expressing the results of your investigations, or experiments?

A. I have. With particular reference to the tidal currents and discharges around Hell Gate, it is very important to get as complete information as practicable in deciding on methods of sewage disposal, and the Metropolitan Sewerage Commission had prepared, by Ernest F. Robinson, who had been with Colonel Black, in charge of the gaugings of the waters in the vicinity of Hell Gate, a digest of the results obtained. Mr. Robinson did that, and the results were published in the 1914 report of the Metropolitan Sewerage Commission. In connection with the studies for disposal, I wrote
590 a report dated December 30, 1915, to the members of the Administrative Committee of the Bureau of Sewer Plan, discussing the discharges and currents arrived at by Mr. Robinson, and this report, with the statement of the ebb and flood volumes, at different points in that vicinity, shown graphically on a map, are contained here (indicating).

Q. Did you prepare other curves to express the studies reported on in that report of December 30, 1915, showing the tidal curves at Sandy Hook and Throgg's Neck?

A. I did not prepare these. These were prepared by Mr. Robinson for his report to the Metropolitan Sewerage Commission, and they were reproduced here, and they are referred to in this report which I wrote.

Q. The larger map in connection with that report was prepared for what purpose, and by whom?

A. That was prepared under my direction, by the Bureau of Sewer Plan, to show points along the Upper East River that were available for sewage disposal purposes, and especially with reference to the currents and depths in the Upper East River. The areas selected as favorable for disposal are shown dotted on the land, and the depths of water are indicated by contours, and the very shallow water, by dots.

Q. And was this with a view to aiding you in your studies
591 for the advantageous disposal of the sewage and trade waste, of part of the City of New York?

A. It was.

Dr. O'Sullivan: I ask that this report with the accompanying maps be marked in evidence as Complainants' Exhibit No. 223.

By Mr. Riker:

Q. The typewritten matter which composes a part of this offer, was prepared by you, Mr. Allen?

A. Yes.

Q. And is based upon your own understanding of the studies?

A. Yes.

Q. Of what?

A. Of the problem of disposing of sewage collected to that part of the harbor near Hell Gate and the Kills and Upper East River.

Q. Now, what did you do personally in securing the data upon which these conclusions were based?

A. The data of flow is taken from Mr. Robinson's experiments, as being the best and most reliable for those particular points that we have. The other data on that are related to the matter, such as the flow and the tidal range in the Hudson and the Upper Bay, were obtained from the Coast Survey.

Q. Well, then, the facts assumed in making the report were none of them secured by you personally, were they?

A. No. As far as the flow of the stream is concerned, I did not make the gaugings. I did not make the observations to de-

592 termine the tidal prism, or the tidal range or discharge.

Q. In this report, what facts as the basis of the report were actually determined by you personally?

A. I do not know that.

Q. Where is Mr. Robinson now?

A. He has been with the Army for two or three years, in France. I think he is back now. I am not sure. I think he is in the regular army now.

Q. You do not know where?

A. No.

Q. For what purpose was this report prepared by you?

A. In a discussion of the relative advisability of collecting and disposing of the sewage in the vicinity of Rikers Island and Ward's Island. It is a matter that has been under considerable discussion, and that was the immediate cause for this report.

Q. I note that report appears to be dated December 30th, 1915. Is that the correct date, so far as you recall?

A. Yes.

Q. Of the making of this report?

A. Yes.

Q. When were these diagrams and maps prepared?

A. Those were prepared, if I remember correctly, in 1914, just prior to the termination of the Metropolitan Sewerage Commission's work.

Q. And constitute a part of the report?

A. The diagrams were not published. The report was published.

Q. I was not speaking of the publication of it. This re-

593 port is directed to the members of the Administrative Committee, Bureau of Sewer Plan?

A. Oh, yes.

Q. Were these diagrams attached to that report, when submitted?

A. Yes.

Q. And were for the purpose of determining available points of discharge of sewage of the City of New York purified or partly purified?

A. Yes.

Q. And the report, I suppose, speaks for itself, as to what parts of the City of New York it is intended to serve?

City of New York,

Board of Estimate and Apportionment,

Bureau of Sewer Plan,

Municipal Building, Room 1235.

File 2.1.

Dec. 30, 1915.

To the Members of the Administrative Committee, Bureau of Sewer Plan.

GENTLEMEN:

At a meeting of your Committee, held Dec. 14, 1915, to consider plans for the treatment of the sewage of The Bronx, I was requested to furnish data concerning the tidal conditions in the Upper East River as affecting the location of outlets, and I submit herewith such of the essential facts, so far as available, which are pertinent to this matter.

In general it may be said that the net flow in the Upper East River is westerly by an amount estimated at 459,900,000 cubic feet every 12 lunar hours. Of this, 44,500,000 cubic feet pass through the Harlem River to the Hudson. These figures are the best available but cannot be considered conclusive. The currents are more favorable for dispersion of the effluent in the Lower East River and the Harlem River than in the Upper East River, but the waters of the Upper East River are cleaner as the Sound is approached and therefore in a more favorable condition to receive sewage. Considering the rapid tidal flow, however, the difference between the waters near Rikers Island and those at Hell Gate does not appear to be a controlling factor.

Tidal Currents in the Vicinity of Wards Island and Rikers Island.

Tidal Conditions.

Hell Gate divides the East River into two parts which differ greatly in their tidal phenomena. This is principally due to the fact that, owing to a certain throttling effect at this point and to an interference of the tidal waves entering the river from Long Island Sound on the east and from New York Bay on the south, the tidal range is greater in the Upper East River than south of Hell Gate and variations from normal conditions due to wind, etc., cause the tidal waves to meet at different points. Under normal conditions they meet in the vicinity of Throgs Neck, or the entrance from the Sound. These varying conditions, dependent mainly on the phase of the moon and the wind and also the upland flow passing down the Hudson River into the Upper Bay, have made it very difficult and costly

to determine what may be called average velocities and volumes of flow in each direction. Nevertheless the Government through the United States Coast and Geodetic Survey, and the War and Navy Departments have acquired a large amount of information on these matters by experiment and study.

The streams most intimately connected with this discussion are the Upper and Lower East River and the Harlem River, although these are in turn influenced by conditions in the Sound, the Upper Bay and the Hudson River.

The tide normally rises and falls:

In the Upper East River:

7.2 ft. at Throgs Neck and
6.6 " " Lawrence Point.

In the Lower East River:

5.0 ft. at Blackwells Island Light,
4.0 ft. at East 27th Street, and
4.2 ft. at Brooklyn Bridge.

In the Harlem River:

5.5 ft. at East 110th Street,
6.0 ft. at High Bridge, and
4.3 ft. at Kings Bridge.

From tide gages observed by the Department of Docks and Ferries at Pier A, North River, and College Point it appears that about once a year, on an average, the level at high tide will reach 3.7 ft. in the Upper East River and 2.5 ft. in the Lower East River above the level of mean high water.

Diagrams 1 to 5* show the tidal elevations above or below mean tide level at Sandy Hook and Throgs Neck, Lawrence Point and Hallets Point, Lawrence Point and 112th Street, East Harlem (Bronx) Kills and Willis Ave. and Spuyten Duyvil and Willis Ave. Bridge, at different times after the moon's transit. For instance, it is seen that high water occurs at

Sandy Hook.....	7.3	lunar hours**	after	the	moon's	transit.		
At Lawrence Point...	10.61	"	"	"	"	"	"	"
At E. Harlem Kills..	11.05	"	"	"	"	"	"	"
At Willis Ave. Bridge	9.7	"	"	"	"	"	"	"

From float experiments the maximum surface velocities or those at "strength of tide," were in general found to be about 1.2 ft. per sec. in the Upper East River, 3 to 4 ft. per sec. in the Lower East River and 3.5 ft. per sec. in the Harlem River.

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*Prepared by Met. Sew. Com.

**A lunar hour = 1.035 solar hours.

At Hell Gate they reach about 7 ft. per sec. on both ebb and flood. Between Hallets Point and Wards Island velocities of 13 ft. per sec. have been observed on the flood.*

Assuming the Lower East River to join the Upper East River opposite Lawrence Point and the Harlem River opposite 126th St.,** the following data were computed by the Metropolitan Sewerage Commission.

	Upper East River.	Lower East River.	Harlem River.
Area at mean low water, sq. mi.	9.23	4.24	0.77
Volume below mean low tide, million cu. ft.	5512	4174	285
Mean depth below mean low tide, feet	21.4	35.4	13.3
Tidal prism, million cu. ft.	1869	352	148

The difficulty in securing reliable gagings in the East River has been mentioned. The United States Coast and Geodetic Survey made gagings in 1871, 1885 and 1886. The latter made at 19th Street by Prof. Mitchell gave:

Ebb	4,455	mil. cu. ft.
Flood	4,007	" " "
Ebb excess	448	" " "

In 1908, at the request of the Metropolitan Sewerage Commission, the United States Coast & Geodetic Survey reviewed all previous data and arrived at the opinion that the ebb flow "can be not more than 1 or 2 per cent greater than the volume transmitted east-ebb."***

In 1910-1911 observations were made under direction of Col. W. M. Black, U. S. A., of the currents and volumes passing through the part of the East River near Hell Gate and the results were worked up by Mr. E. F. Robinson, Assistant Engineer, and subsequently Assistant Engineer to the Metropolitan Sewerage Commission. These furnish the most definite information we have to date, with the following results:

	Million cubic feet per tidal period.		
	Ebb.	Flood.	Excess ebb.
Hell Gate	4482.7	4221.2	261.5
Little Hell Gate	326.5	183.7	142.8
Harlem (Bronx) Kills	113.0	57.5	55.5
Harlem River	252.4	207.9	44.5

*Tide Tables 1914, p. 406.

**For purposes of this study only. In general the Met. Sew. Com. assumed the South end of the Harlem River at 103 St.

***Rep. Met. Sew. Com. 1914, p. 568.

Diagrams 4, 5, 6 and 7 give the rate of discharge through Hell Gate, Little Hell Gate, Harlem Kills and Harlem River throughout a tidal period, from which the total volumes are computed.

In this connection Mr. Robinson states "In view of the generally accepted figures these values appear to be too large, but they must be regarded as the result of careful field work with observations extending over a period of two years, while other determinations are based upon theory alone."

Nevertheless, on submitting these studies to the United States Coast and Geodetic Survey they are not disposed to alter their former opinion, believing that gagings at other points should supplement those by Col. Black and, in particular, during periods of dry weather flow in the Hudson.

It has been suggested that a net flow westerly through the East River may be entirely lacking, but that this is not the case I think is indicated by other evidence. Analyses of the water of the Upper East River, Lower East River, Upper Bay and Hudson show the following results:

Dissolved Oxygen.

	Per cent saturation.			
	1909.	1911.	1913.	
Upper East River	86	69	76	(Throgs Neck)
Lower East River	65	54	43	
Upper Bay	67	72	66	
Hudson River	72	62	57	

From this it appears that the Lower East River, as would be expected, is the most polluted and the Upper East River the least polluted of these waters. If the flow were easterly one would expect the Upper East River to partake more nearly of the character of the Lower East River and Bay.

Bacteria in Water.

	1909.	
Long Island Sound	310	per cc.
Upper East River	3,100	per cc.
Lower East River	6,100	per cc.
Upper Bay	12,500	per cc.
Hudson River	6,600	per cc.

The same deduction may follow here as with dissolved oxygen, but it may be objected that oxygen may be increased by absorption from the air and the bacteria die out by natural agencies in travel toward the Sound.

A more convincing test is in the salinity of the water, salt being a constituent that persists and is easily identified. Now if the resultant current were easterly the entire western end, at least of Long Island Sound, as well as the East River, would partake of the char-

acter of the Upper Bay modified by the fresher water entering by way of the Harlem River. That is, we should expect a salinity indicating something less than the amount of sea water found in the Upper Bay. Observations made three times a day for over a year, however, show the following percentages of sea water at observation stations in each stream:

Average Percentage of Sea Water.

Upper East River at Throgs Neck	81.9
Lower " " " Blackwells Island	68.1
Upper Bay at Governors Island	63.6
Upper Bay at Robbins Reef	68.8
Hudson River at Ft. Washington Point	33.7

Again, a series of salinity determinations were made April 13-15, 1909 extending from Greenport Harbor, at the easterly end of Long Island Sound, through the Sound and East River to the Williamsburgh Bridge, as follows:

Percentage of Sea Water.

Greenport Harbor	90
Hortons Point	88
Roanoke Landing	86
Woodville Landing	84
Mount Misery Point	82
Smithtown Bay	80
Lloyds Point	78
Matinicock Point	76
Prospect Point	74
Throgs Neck	70
Clason Point	64
Williamsburgh Bridge	60

Now it is inconceivable that such a progressive decrease in salinity could occur if there were a resultant flow from the Upper Bay with its large percentage of upland water toward the east. Moreover, if there were no resultant in either direction we should expect a decrease in the percentage of sea water in passing from the Upper Bay to Throgs Neck, due to the influence of the Hudson by way of the Harlem River, and of the upland waters entering the Upper East River and Sound from the streams of New York and Connecticut. As the salinity increases regularly from the Bay and East River toward the east the only conclusion is that *there exists a resultant easterly flow through Long Island Sound toward New York Upper Bay* and the only question is as to its magnitude.

It might be supposed that the float observations made by the Metropolitan Sewerage Commission would throw some light on the question. The most that can be said is that the currents are weak and uncertain west of Randalls Island and near Throgs Neck, that

the flood current in the Lower East River tends to pass through Hell Gate and north of Rikers Island, that the flood current in the Harlem River tends to pass through Bronx Kills to the Upper East River, that the entire Lower East and Harlem Rivers are traversed by both the flood and ebb currents but that under certain conditions the resultant ebb flow in the Lower East River is insignificant.

There is, therefore, considerable uncertainty as to any exact values for either average flood or average ebb flows in the East River. If, however, we accept Col. Black's gagings as the best available information, it would appear that there is an excess passing westerly from the Upper East River through Harlem Kills, Little Hell Gate and Hell Gate of 459.9 million cu. ft. per tidal period. Deducting 44.5 million cu. ft. which passes through the Harlem River to the Hudson we get 415.4 mil. cu. ft. as the net ebb passing down the Lower East River* every 12 lunar hours or 6006 million gallons per day.

Of the ebb passing through the Harlem River 45% comes through Harlem Kills and 55% through Little Hell Gate, leaving 187 mil. cu. ft. or 57% of the Little Hell Gate ebb to pass down the Lower East River with the discharge through Hell Gate.

The Relation of Tidal Currents in the Upper East River to Sewage Disposal.

In discussing questions of sewage disposal the Upper East River may be conveniently considered as divided into two parts by the waters lying between the mouth of the Bronx River and Flushing Bay. To the east of this the influence of the clean waters of Long Island Sound is more marked, the populations less dense and the necessity for thorough treatment of effluents more remote than in that portion lying between the above location and the Lower East River. The present discussion is with especial reference to this more westerly portion of the Upper East River.

The accompanying map (No. 2) shows in a general way the areas of deep and shallow water, the points at which it is pretty well agreed that sewage effluents will be discharged and other points where such discharge may reasonably be considered.

If it should be decided to treat the sewage from the nearer portion of Manhattan (amounting to 92 mgd. in 1940) on Wards Island, together with 73 mgd. from The Bronx, there would then be discharged into Hell Gate 165 mgd. And if, according to the plan recommended by Black & Phelps, 90 mgd. from 12,489 acres in Queens be discharged in the future near Rikers Island this would make, with 43 mgd. from The Bronx, 133 mgd. discharged in this part of the river. If, however, all the sewage from this part of The Bronx be taken to Rikers Island there would be discharged near Wards Island 92 mgd. and near Rikers Island 206 mgd.

In deciding on the relative advantages of these two plans it is believed that the resulting difference in the general condition of the

*As computed by Prof. Mitchell in 1886 this was 418 mil. cu. ft.

river water will not be great, as the two locations are not over two miles apart, whereas the effluent travels by the tidal currents some 9 or 10 miles every six hours. There is a positive advantage in dividing the effluent between two points of outlet in securing a more rapid diffusion. The channel is sufficiently deep at either point, although that near Wards Island is the deeper. The currents, too, are swifter here, the mixing effect would be more thorough and the effluent would find its way from this point to the Upper Bay and Narrows more quickly than from near Rikers Island.

On the other hand the flood current would carry more of the effluent from Rikers Island to and beyond the entrance to the Sound and there would be a considerable reduction in organic matter before its return. The ebb flow, however, would carry the Rikers Island effluent down, but not out of, the Lower East River except for the 10% which finds its way into the Harlem River.

It is not possible to state the precise effect on the river as regards pollution in each plan numerically for there are too many variable elements to be taken into account, so that a decision must be reached largely as a matter of judgment, having in view and properly weighing all the facts of the case.

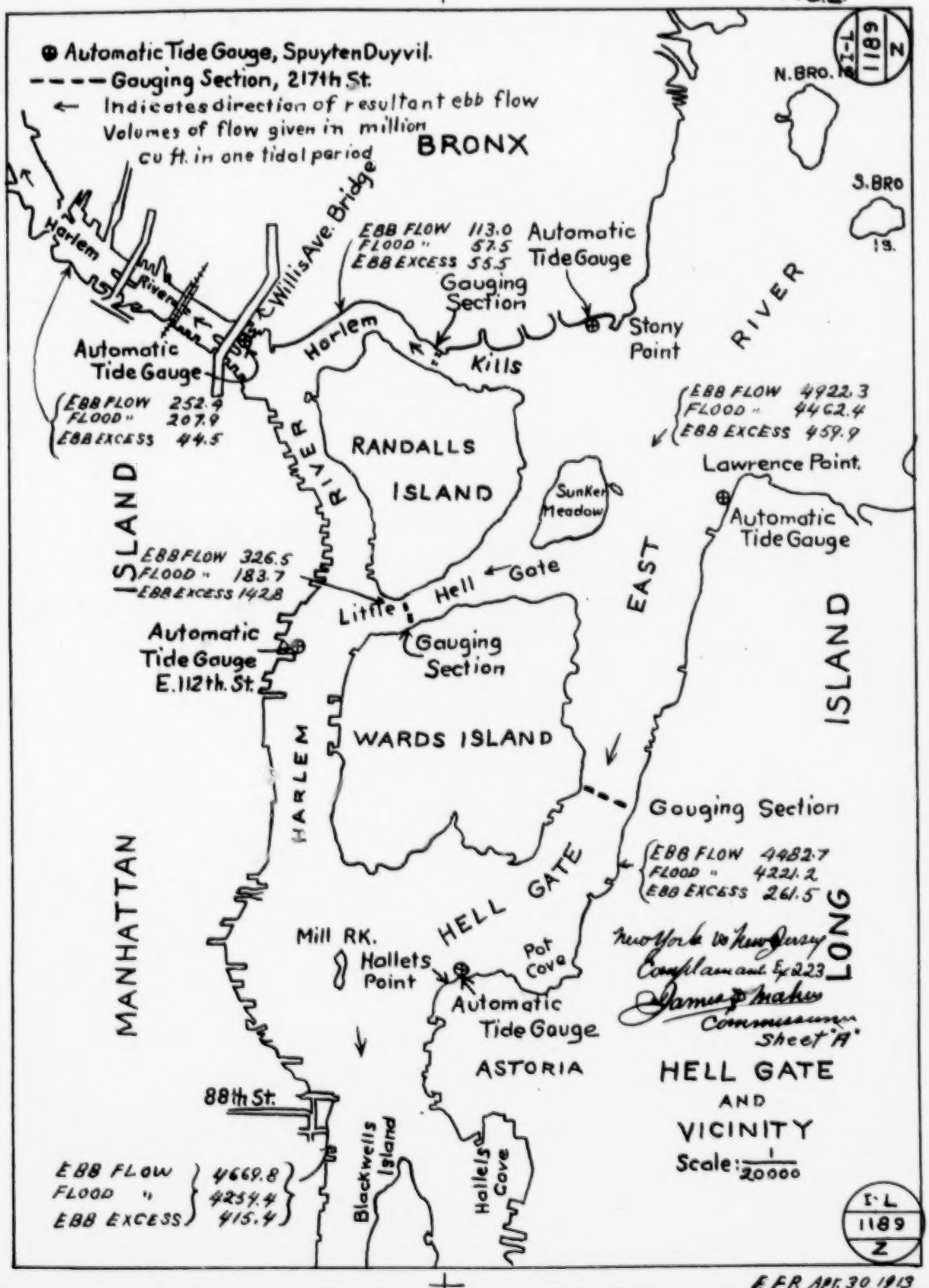
Respectfully submitted,

KENNETH ALLEN,
Engineer.

Illustrations.

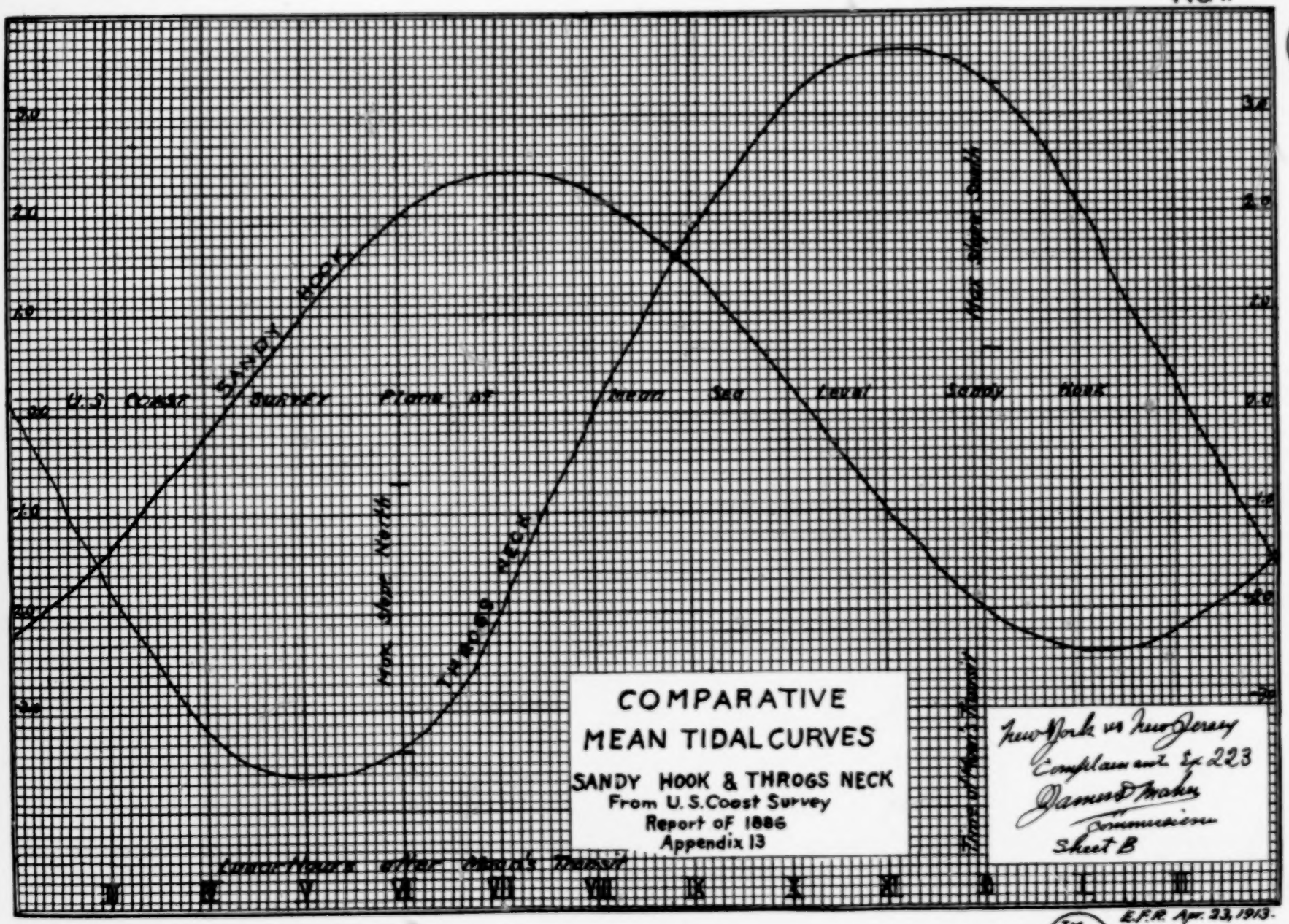
Map 1. Map showing tidal flows near Hell Gate.
Diag. 1. Comparative tide curves—Sandy Hook & Throgs Neck.
" 2. " " " —Lawrence Pt. & Hallets Pt.
" 3. " " " — " " & 112th St.
" 4. " " " —E. Harlem Kills & Willis Ave.
" 5. " " " —Spuyten Duyvil & " "
" 6. Discharge curve—Hell Gate.
" 7. " " —Little Hell Gate.
" 8. " " —Harlem Kills.
" 9. " " —Harlem River.
Map 2. Map showing location for outlets in Upper East River.

FIG. 2.



E F R Apr. 30 1913

FIG. 1.



COMPARATIVE
MEAN TIDAL CURVES
SANDY HOOK & THROGS NECK
From U.S. Coast Survey
Report of 1886
Appendix 13

New York vs New Jersey
Complainant Ex 223
James D. Maher
Commissioner
Sheet B

E.F.R. Apr. 23, 1913.

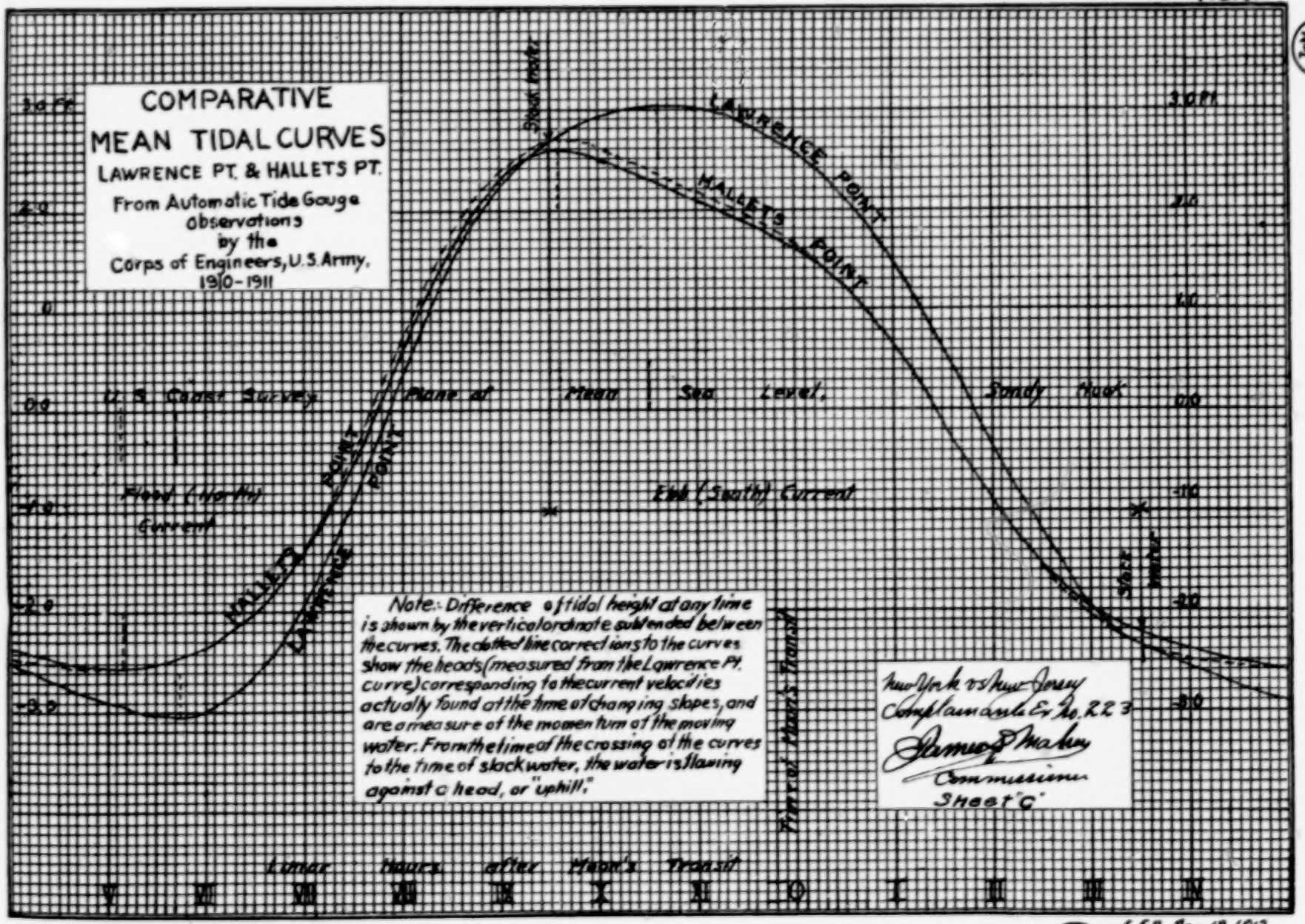
I-M 1188
IM 1188 Z

FIG. 3.

COMPARATIVE MEAN TIDAL CURVES

LAWRENCE PT. & HALLETS PT.

From Automatic Tide Gauge observations by the Corps of Engineers, U.S. Army, 1910-1911

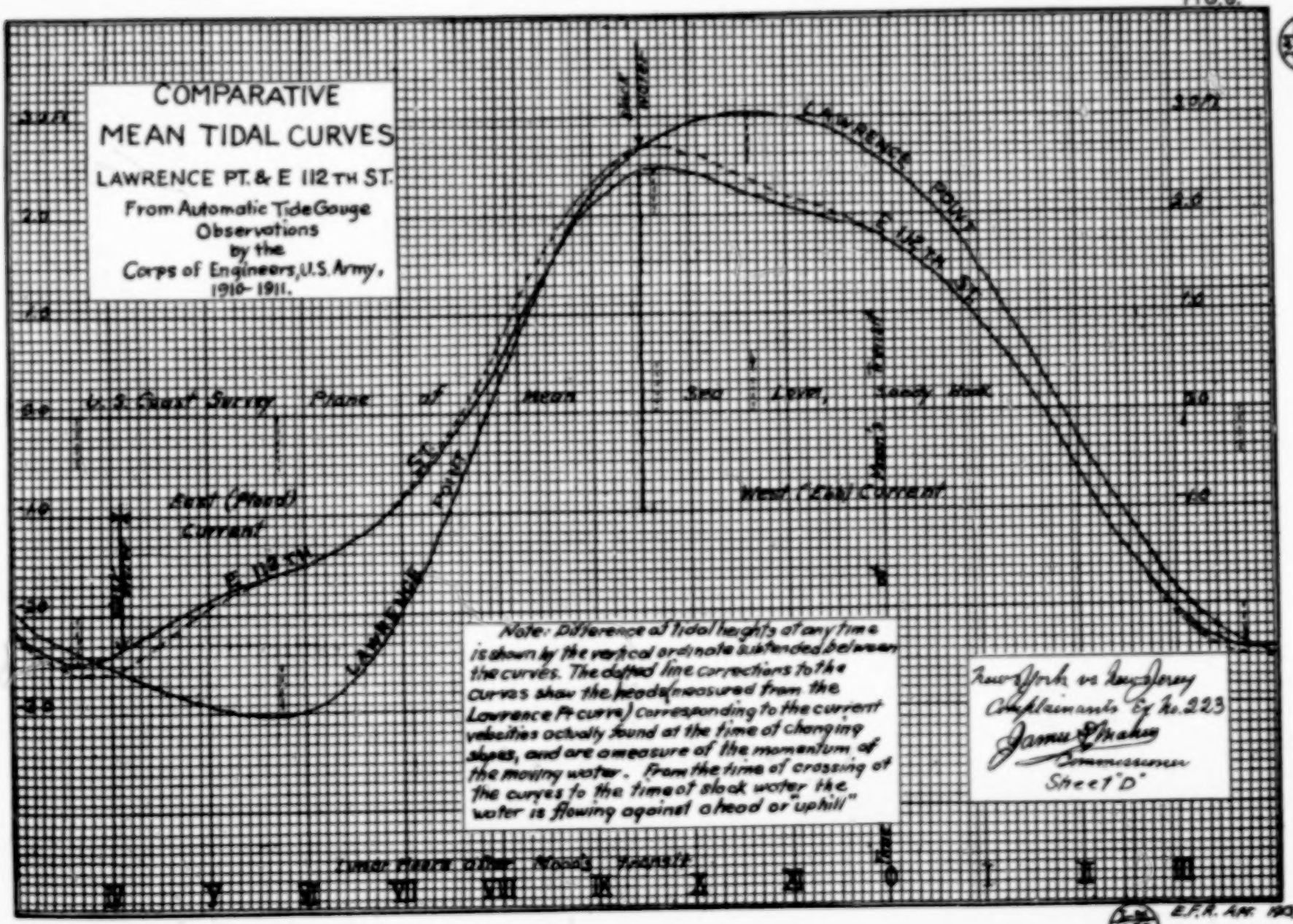


Note:- Difference of tidal height at any time is shown by the vertical ordinate suspended between the curves. The dotted line corrections to the curves show the heads (measured from the Lawrence Pt. curve) corresponding to the current velocities actually found at the time of changing slopes, and are a measure of the momentum of the moving water. From the time of the crossing of the curves to the time of slack water, the water is flowing against a head, or "uphill."

New York vs New Jersey
Complainants Ex No. 223
James S. Shaler
Commissioner
Sheet "C"

E.F.R. Apr. 18, 1913

FIG. 6.



E.F.R. Apr. 1913

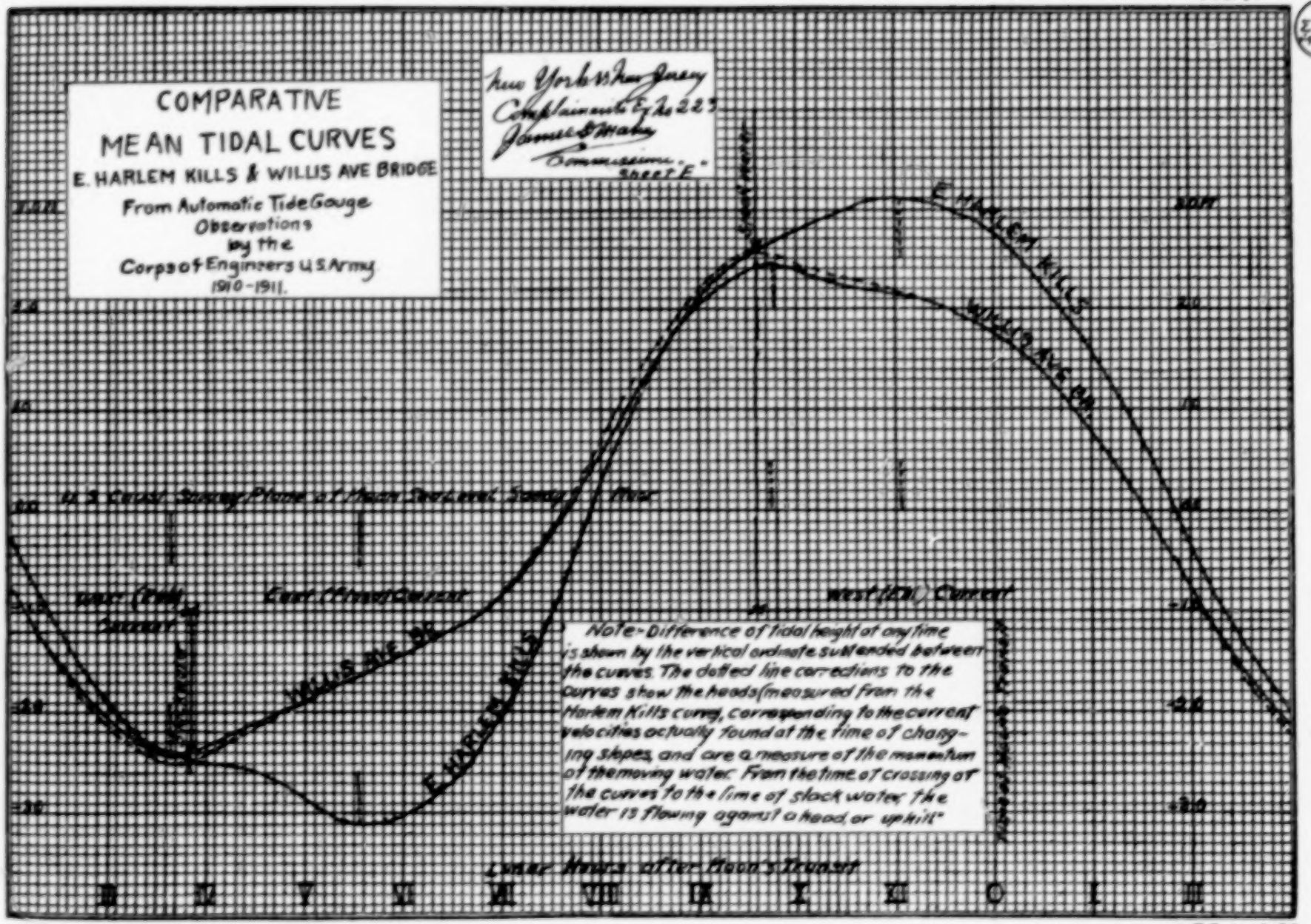

COMPARATIVE
MEAN TIDAL CURVES
E. HARLEM KILLS & WILLIS AVE BRIDGE
From Automatic Tide Gauge
Observations
by the
Corps of Engineers U.S. Army
1910-1911.
New York & New Jersey
Comp. Warrants Eq. No. 223
Sheet E
E. HARLEM KILLS
WILLIS AVE BR
Note- Difference of tidal height of any time is shown by the vertical ordinate subtended between the curves. The dotted line corrections to the curves show the heads (measured from the Harlem Kills curve), corresponding to the current velocities actually found at the time of changing stages, and are a measure of the momentum of the moving water. From the time of crossing of the curves to the time of slack water, the water is flowing against a head, or uphill.
Lunar Hours after Moon's Transit
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
E.F.R. Apr 4, 1913.

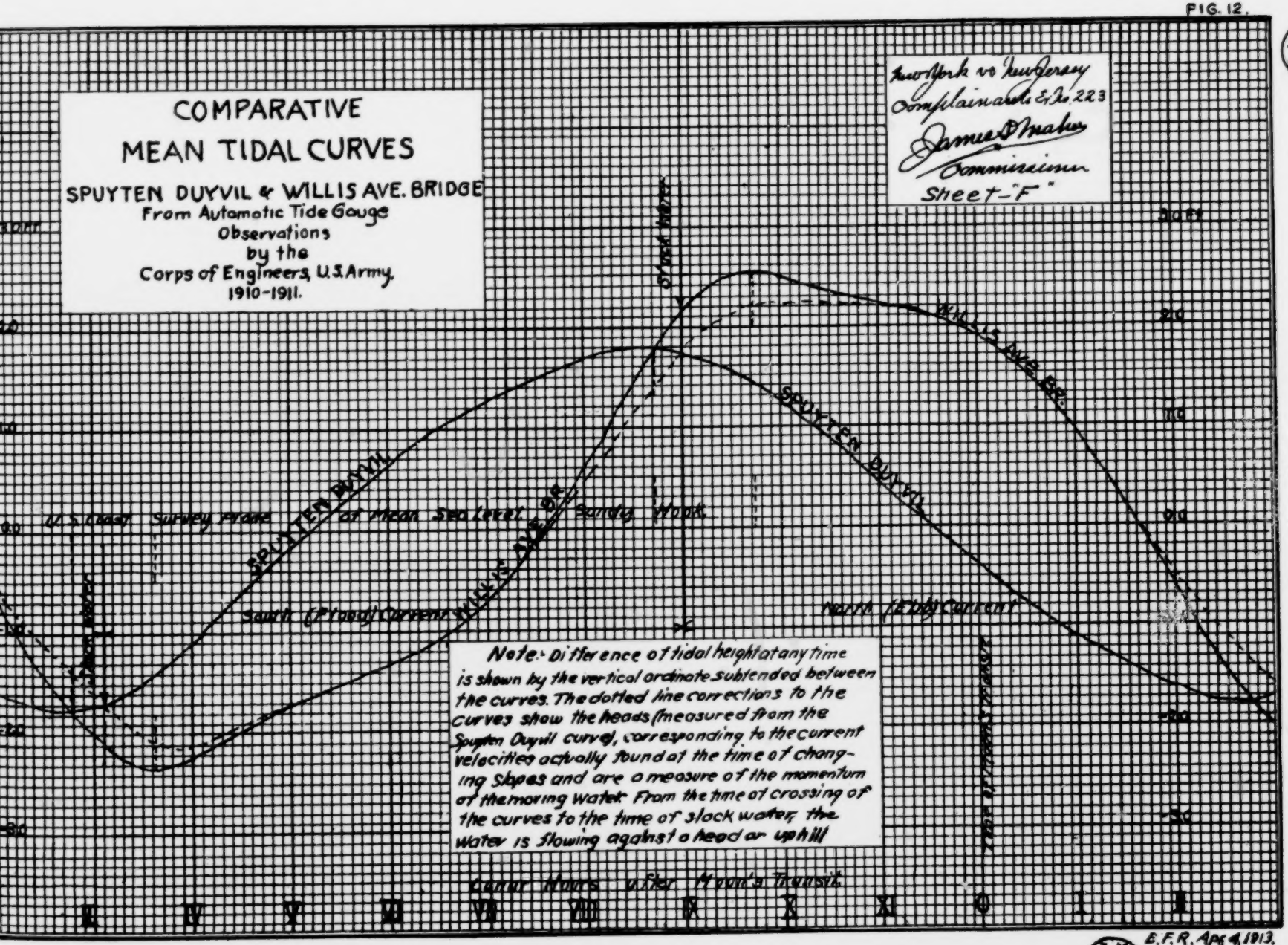
FIG. 12.

I-M 1199 Z

COMPARATIVE MEAN TIDAL CURVES

SPUYTEN DUYVIL & WILLIS AVE. BRIDGE
From Automatic Tide Gauge Observations by the Corps of Engineers, U.S. Army, 1910-1911.

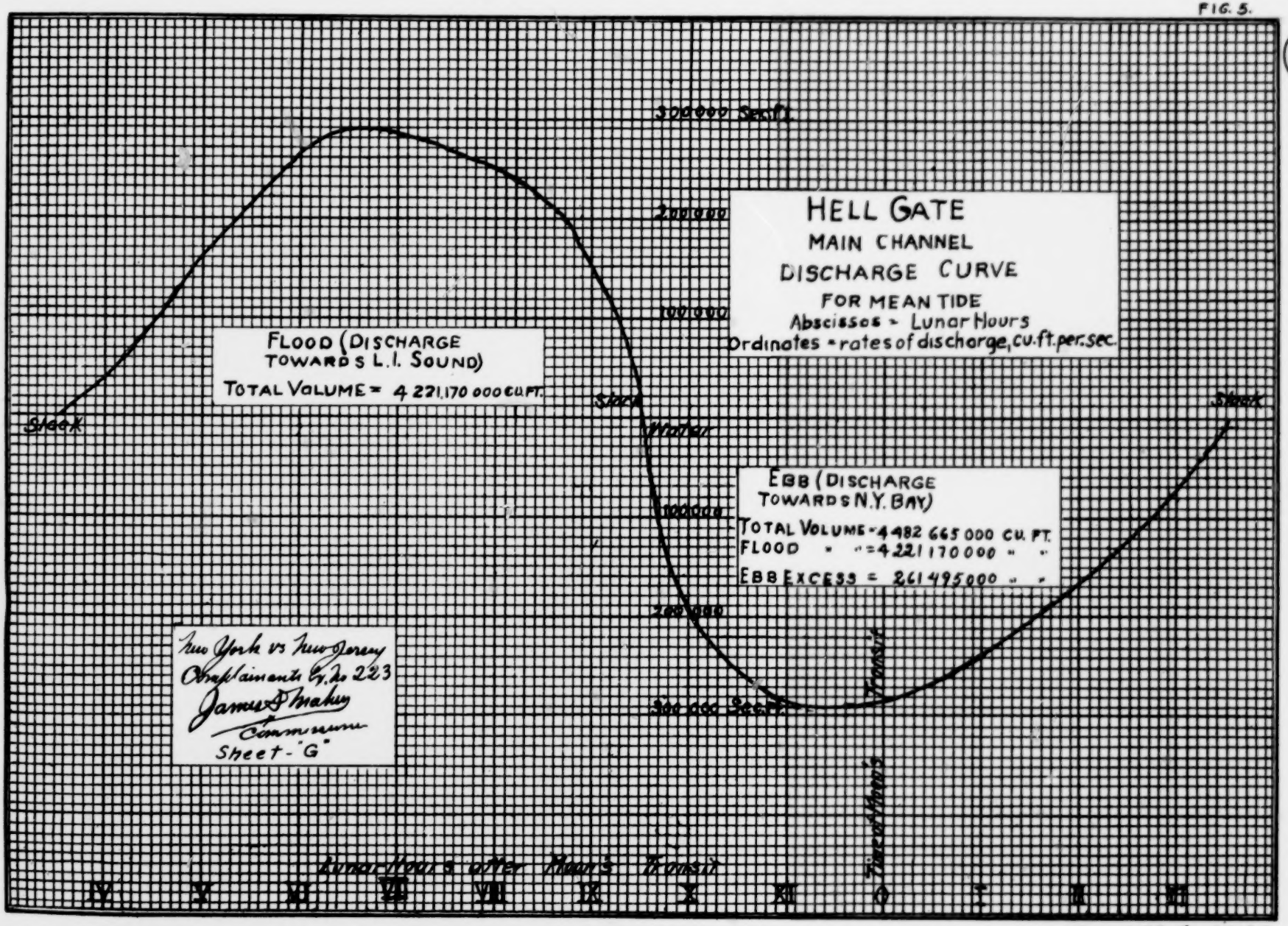
New York vs New Jersey
Complainants Ex. No. 223
James D. Nolan
Commissioner
Sheet-"F"



E.F.R. Apr 4, 1913.

I-M 1199 Z

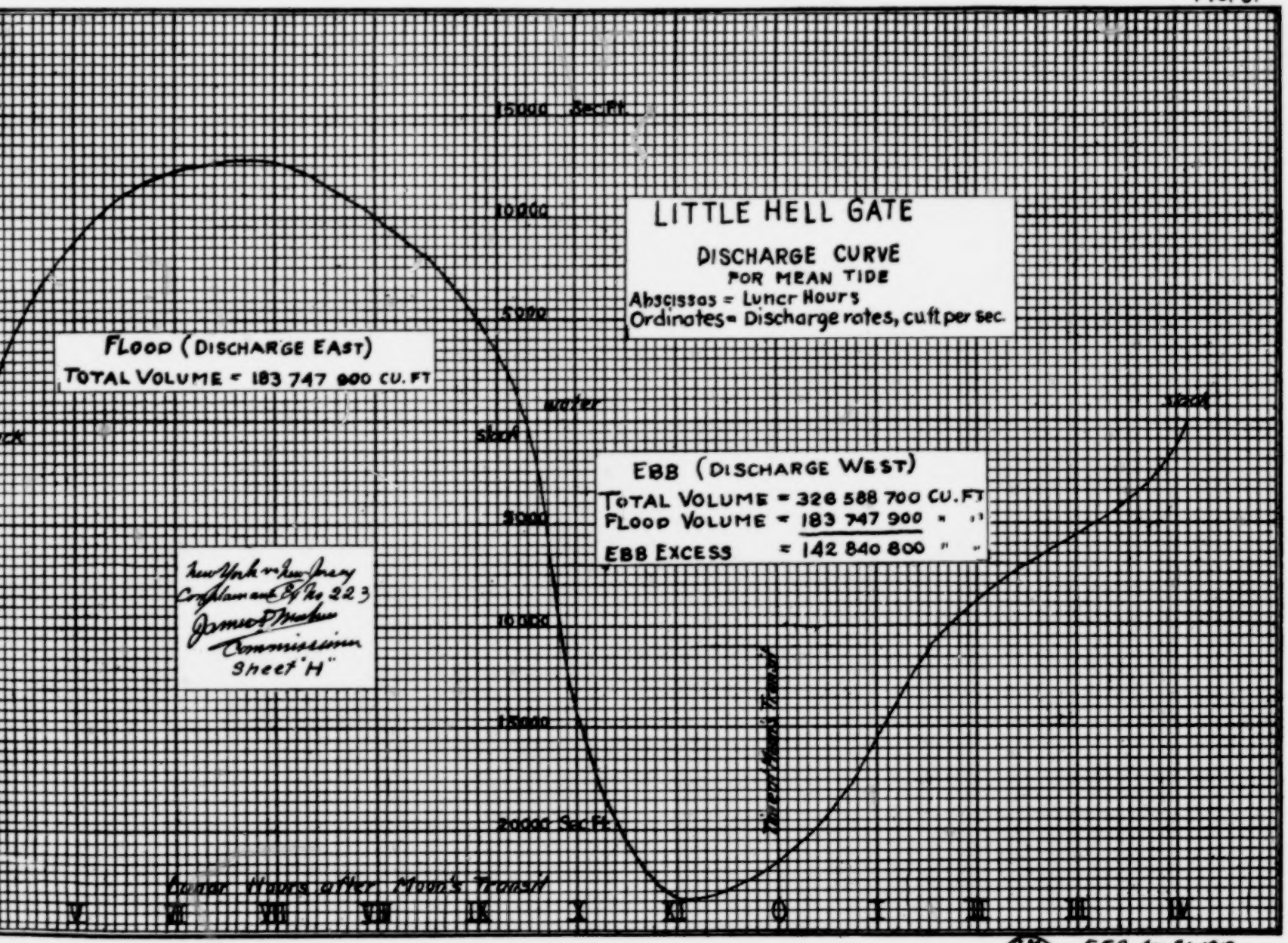
FIG. 5.



E.F.R. Apr 25, 1913

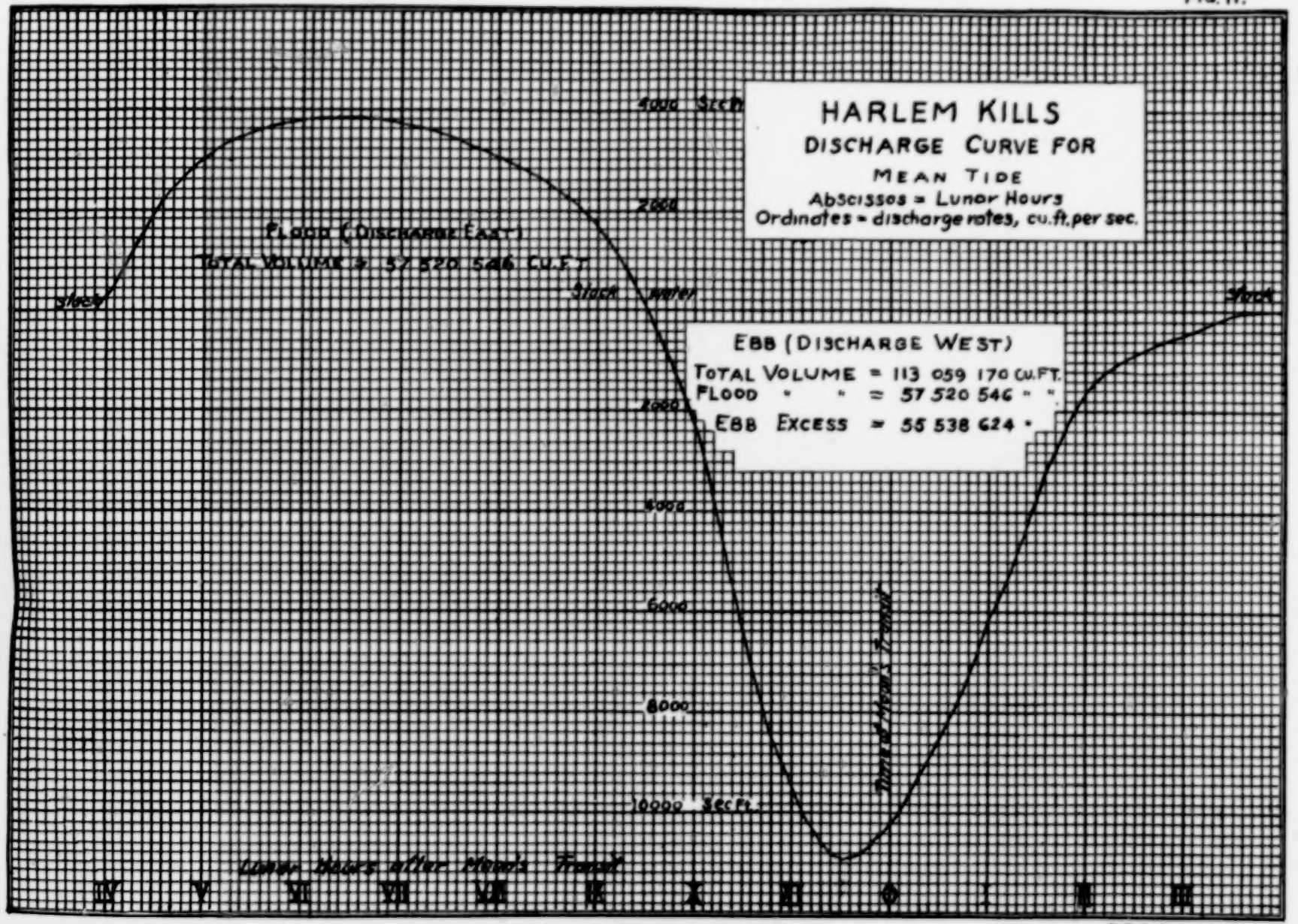
I-M 1192 3

FIG. 8.



E.F.R. Apr 21, 1913.

FIG. 11.

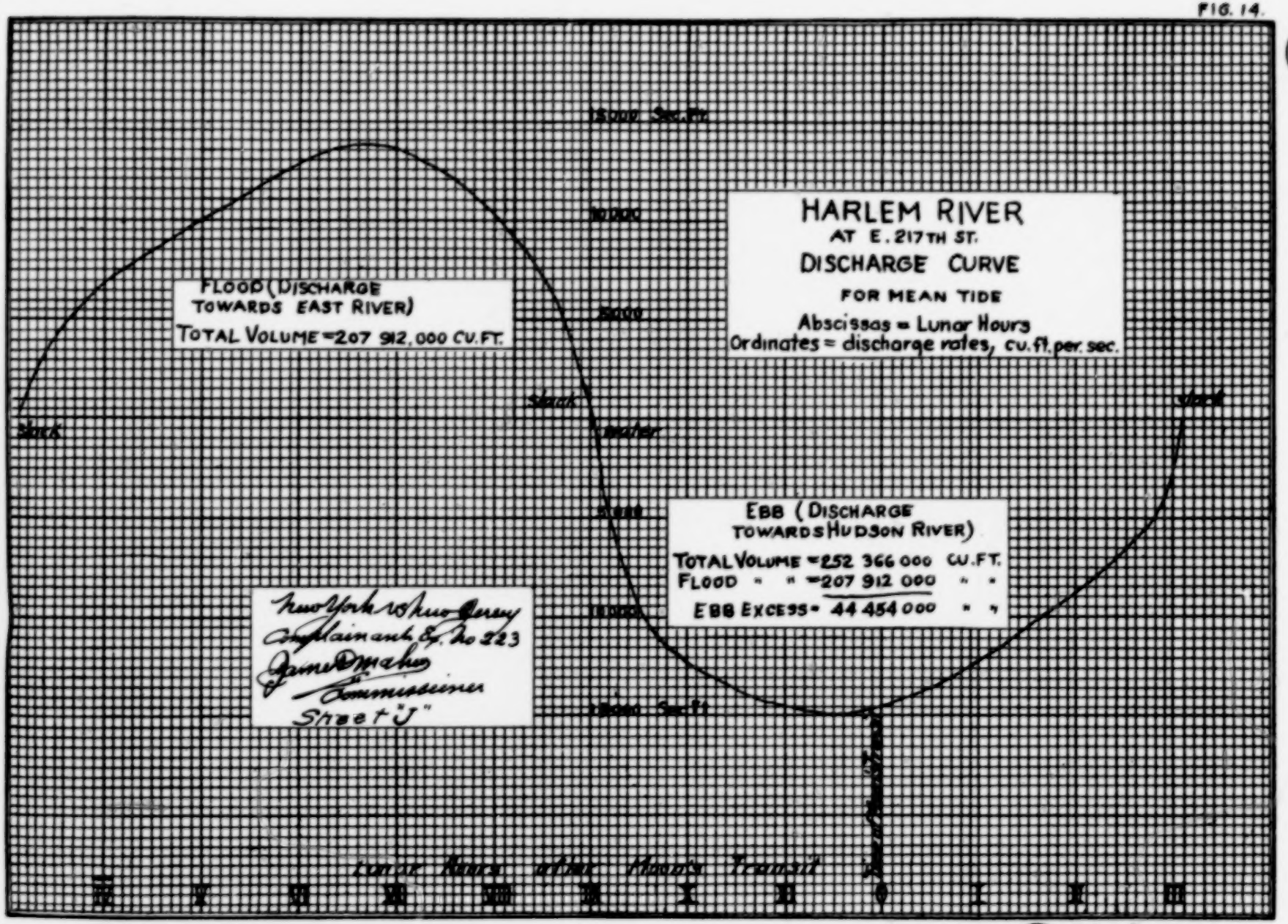


Complainants Exhibit No. 223
Sheet I.

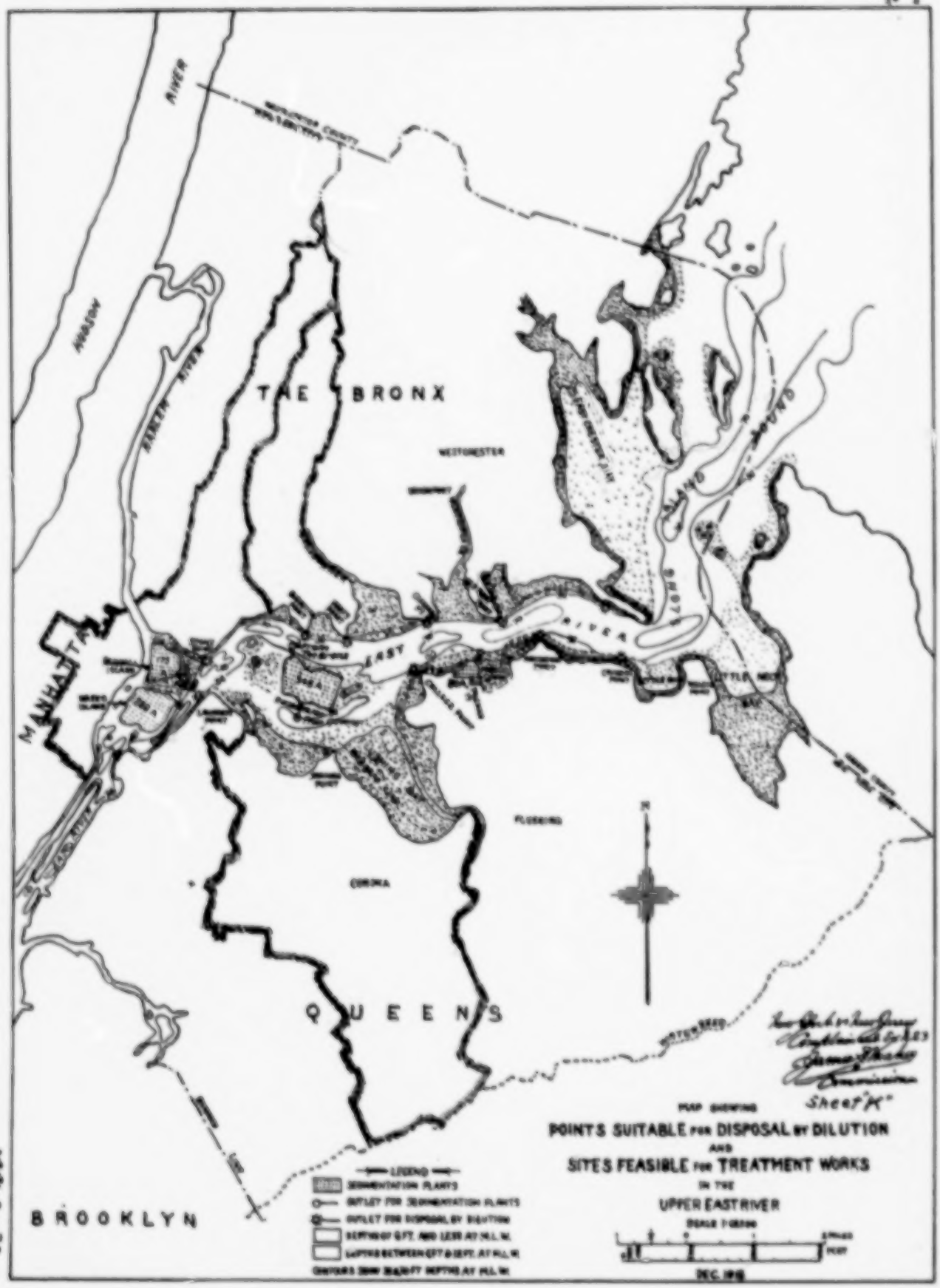
E.F.R. Apr. 15. 1913.

I.M. 1198 Z

FIG. 14.



E. P. R. Apr. 16, 1913.


HUDSON
RIVER
HARLEM RIVER
THE BRONX
WESTCHESTER
EAST
RIVER
MANHATTAN
FLUSHING
CORONA
QUEENS
BROOKLYN
LEGEND
SEDIMENTATION PLANTS
OUTLET FOR SEDIMENTATION PLANTS
OUTLET FOR DISPOSAL BY DILUTION
DEPTHS OF 6 FT. AND LESS AT M.L.W.
DEPTHS BETWEEN 6 FT & 18 FT. AT M.L.W.
CONTOURS SHOW 3 & 10 FT DEPTHS AT M.L.W.
MAP SHOWING
POINTS SUITABLE FOR DISPOSAL BY DILUTION
AND
SITES FEASIBLE FOR TREATMENT WORKS
IN THE
UPPER EAST RIVER
Sheet "K"
DEC. 1918

No. (3) - Fig. 30

A. Yes.

Q. I think you said that the last map indicates the location of available points of discharge of effluent in disposal plants?

A. Yes.

Mr. Riker: The offer is objected to, Mr. Commissioner, on the ground that it is based upon data not within the knowledge of the witness, which he has taken from reports, and the makers of the report, or the maker of one of the reports, certainly being alive and available.

The Commissioner: The objection of counsel for defendant is noted.

Dr. O'Sullivan: The offer is pressed for the reason that complainants' counsel is obligated to confine his testimony to that of three engineering experts, and if defendants' counsel will waive the limitation and permit me to produce those who did the original
594 work on which many of these exhibits were based, complainants' counsel will produce witnesses who did the original work under the present witness's direction.

Mr. Riker: I am afraid that counsel for the complainants would not be permitted by the court to waive the terms of the order, if disposed to, and counsel for the defendants were also under the same embarrassment in the testimony offered by him, and is therefore not willing to waive the requirements of the order if he could possibly do so.

(The paper was marked Complainants' Exhibit No. 223.)

(Here follows map marked page 594a.)

Q. Have you either investigations or experimental determinations to arrive at data relative to the average discharge of fresh water into our harbor waters, and, when I say "fresh water," I mean land water.

A. The United States Coast & Geodetic Survey, in answer to certain questions put to them by the Metropolitan Sewerage Commission, made estimates of the amount of fresh water discharged to the different bodies of water, and for the different months of the year, and for the Narrows and for the Hudson I have plotted these in the form of a diagram, showing in white the volume of water ordinarily discharged by the Hudson River at its mouth, in cubic feet per second, and shown in red, the additional volume which comes in between the mouth of the Hudson and the Narrows, and passes out to the ocean. For instance, in January, a little
595 over 18,000 cubic feet per second is the average of the mean discharge of the Hudson River from above. While the discharge in January through the Narrows is a little more than 20,000 cubic feet per second; that is, the mean discharge of fresh water through the Narrows is a little over 20,000 cubic feet per second.

Q. When you use the term "fresh water," do you mean land water?

A. I mean land water.

Q. Have you visualized those figures and shown their relative proportions in a diagram?

A. Yes.

Dr. O'Sullivan: I offer this diagram in evidence, and ask that it be marked Complainants' Exhibit No. 224.

By Mr. Riker:

Q. I understand this chart to be a graphic delineation of the results of information furnished by the Coast & Geodetic Survey?

A. That is right.

Q. Is that information published in any report?

A. It is published in the year 1914 Report of the Metropolitan Sewerage Commission.

Q. Not published by the Coast & Geodetic Survey in any official volume?

A. No, not that I know of.

Q. And so far as you are concerned, you have no way of knowing whether it was accurate or not?

A. No.

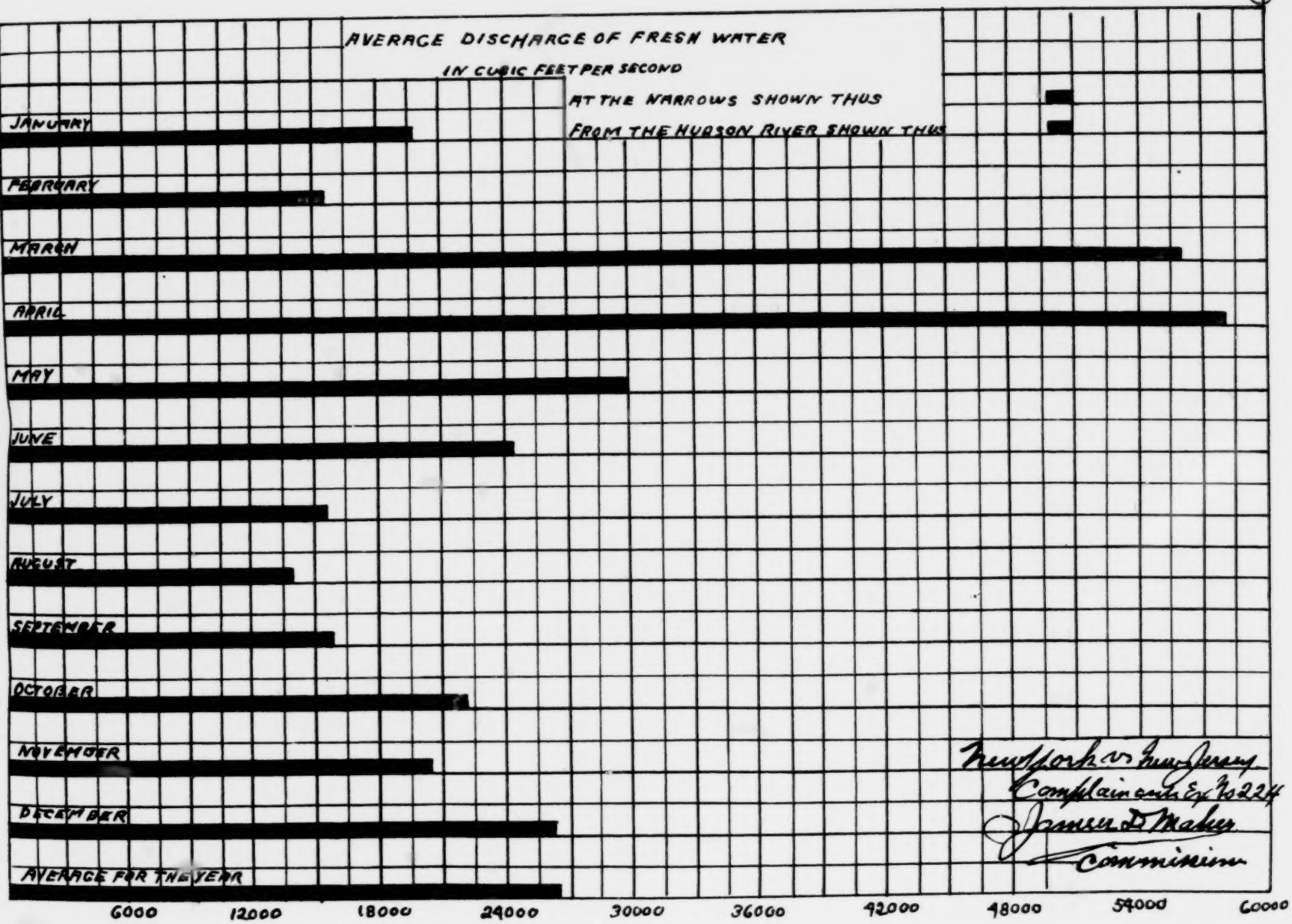
Q. Except reliance upon the return made to the questions by the Coast & Geodetic Survey?

A. Yes.

596 Q. This is only a graphic statement of the results of that inquiry made of the Coast & Geodetic Survey?

A. Yes, sir.

Q. Do you know how the Coast & Geodetic Survey undertook to determine the answers to the questions propounded by the Metropolitan Sewerage Commission?


AVERAGE DISCHARGE OF FRESH WATER
IN CUBIC FEET PER SECOND
AT THE NARROWS SHOWN THUS
FROM THE HUDSON RIVER SHOWN THUS
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
AVERAGE FOR THE YEAR
6000
12000
18000
24000
30000
36000
42000
48000
54000
60000
New York vs New Jersey
Complainants Ex No 224
James D Maher
Commissioner

A. You mean on any particular question?
Q. Yes, of your own knowledge?
A. I think that is stated in their letter contained in that report. It is based on the rainfall and computation of the run-off.
Q. Is that the recognized method of arriving at those results?
A. Yes.
Q. In determining the run-off, is it necessary to determine the drainage area naturally?
A. Yes.
Q. And the conditions so far as run-off may be determined by physical conditions in the drainage area?
A. Yes.
Q. Do you know what was done in determining that, by the Coast & Geodetic Survey?
A. The Government had made gaugings in the Upper Hudson and on the Mohawk Rivers, and some tributaries, I think there have not been gaugings of the stream below. The total run-off was assumed in proportion to the additional area below the areas for which the run-off was measured.
Q. That is an approximation, as most of these things are?
A. Yes.

Mr. Riker: The offer is objected to, Mr. Commissioner,
597 on the ground that it only purports to be a graphic delineation of the results of determinations, not made by the witness, and not contained in any official report, by the body which purports to have made the determination.
The Commissioner: The objection will be noted.

(The paper was marked Complainants' Exhibit No. 224.)

(Here follows chart marked page 597*a*.)

By Dr. O'Sullivan:

Q. With regard to the data relative to precipitation and run-off, where did you get such data?

A. From the Weather Bureau. I have here the record of the monthly precipitation in New York City, since 1826, shown on a folder inside the cover, and on page 9, and brought up to date in these monthly reports for 1919.

Q. Have you yourself, Mr. Allen, prepared any tables and diagrams relative to the rainfall and run-off in the Hudson River Basin?

A. I have. I have here a map showing the drainage area of the Upper Hudson with the location of four selected points, Indian Lake, Little Falls, Albany, and Wappingers Falls, where rainfall records were kept by the Government for certain years, 1917, 1909, 1911; these were tabulated up to October of the last year by the Metropolitan Sewerage Commission and shown on one of these prints. From that date the table has been completed by myself, and other tables showing all of the other years from 1908 up to the end of 1918, for the same points, are shown on points in
598 this exhibit.

Dr. O'Sullivan: I offer the tabulations and the diagram testified to just now by this witness, in evidence, and ask that they be marked Complainants' Exhibit No. 225.

By Mr. Riker:

Q. This offer consists apparently of four sheets of blue-print. Now, taking the first one, which is endorsed "Sketch map showing locations of rainfall stations," from what was that taken?

A. That was taken from a larger map showing the area drained into the Hudson.

Q. Who prepared the larger map?

A. I do not know who prepared the larger map.

Q. And who prepared the reduction?

A. C. A. Holden.

Q. Who is he?

A. He was an Assistant Engineer on the Metropolitan Sewerage Commission.

Q. Did you have anything to do with it?

A. No.

Q. What did you have to do with the first sheet of this paper you offer?

A. Nothing.

Q. Is it published?

A. No.

Q. Now, turning to the second sheet which is a tabulation, who prepared the tables included in the second sheet of the offer?

A. The same man, C. A. Holden, down to the end of September, 1911.

Q. Did you have anything to do with it?

A. I prepared the rest of it.
Q. I mean down to that date, you had nothing to do with it?
A. No.
Q. Do you know whether it is correct or not?
A. No.
Q. Now, the balance of it you say you prepared?
A. Yes.
Q. What dates does the balance of that show?
A. Up to October 1st, 1911.
Q. Where did you get your data from?
A. From the tables that have been presented—from tables furnished by the United States Weather Bureau.
Q. They report the gaugings at different stations, do they?
A. Yes.
Q. Of the run-off of the Hudson River at those points?
A. No.
Q. What?
A. Just gaugings for rainfalls.
Q. Just gaugings for rainfalls?
A. Yes.
Q. And those are contained in the official publications of the Weather Bureau?
A. Yes.
Q. Of the State of New York or of the United States?
A. The United States.
Q. New York has no weather bureau, has it?
A. No.
Q. You do not, of course, undertake to say whether they are correct or not, beyond the fact that they are official records?
A. No.
Q. And all you have done is to tabulate them by months, is not that all?
A. That is right.
Q. And put them into this table?
A. Yes.
Q. I say "all you have done"; have you done anything else shown on the second sheet?
A. I summarized those on the last line.
Q. That summary consisted of what, averaging?
A. Averaging, those four figures for that last year.
Q. You did that yourself?
A. Yes.
Q. Outside of the mechanical preparation of the table, then all that you personally did was to average those last four figures?
A. That is all.
Q. The third sheet contains what, Mr. Allen?
A. It contains the results for other years.
Q. For other years of precipitation at these stations?
A. Yes.
Q. And that is taken by you personally from the same source?

A. Yes.
Q. And did you make the averages in these cases?
A. Yes.
Q. Outside of the actual mechanical tabulation of them, that is all you did?
A. Yes.
Q. And the fourth sheet is of the same character?
A. Yes.

Mr. Riker: The offer is objected to on the ground that it does not contain any independent work by the witness, and the facts ascertained by him; and also on the ground that it is not relevant and material to the inquiry directed by the United States Supreme Court.

The Commissioner: The objection of counsel for the de-
601 fendant has been noted.

(The paper was marked Complainants' Exhibit No. 225.)

(Here follows table marked page 601*a*.)

METROPOLITAN SEWERAGE COMMISSION OF NEW YORK

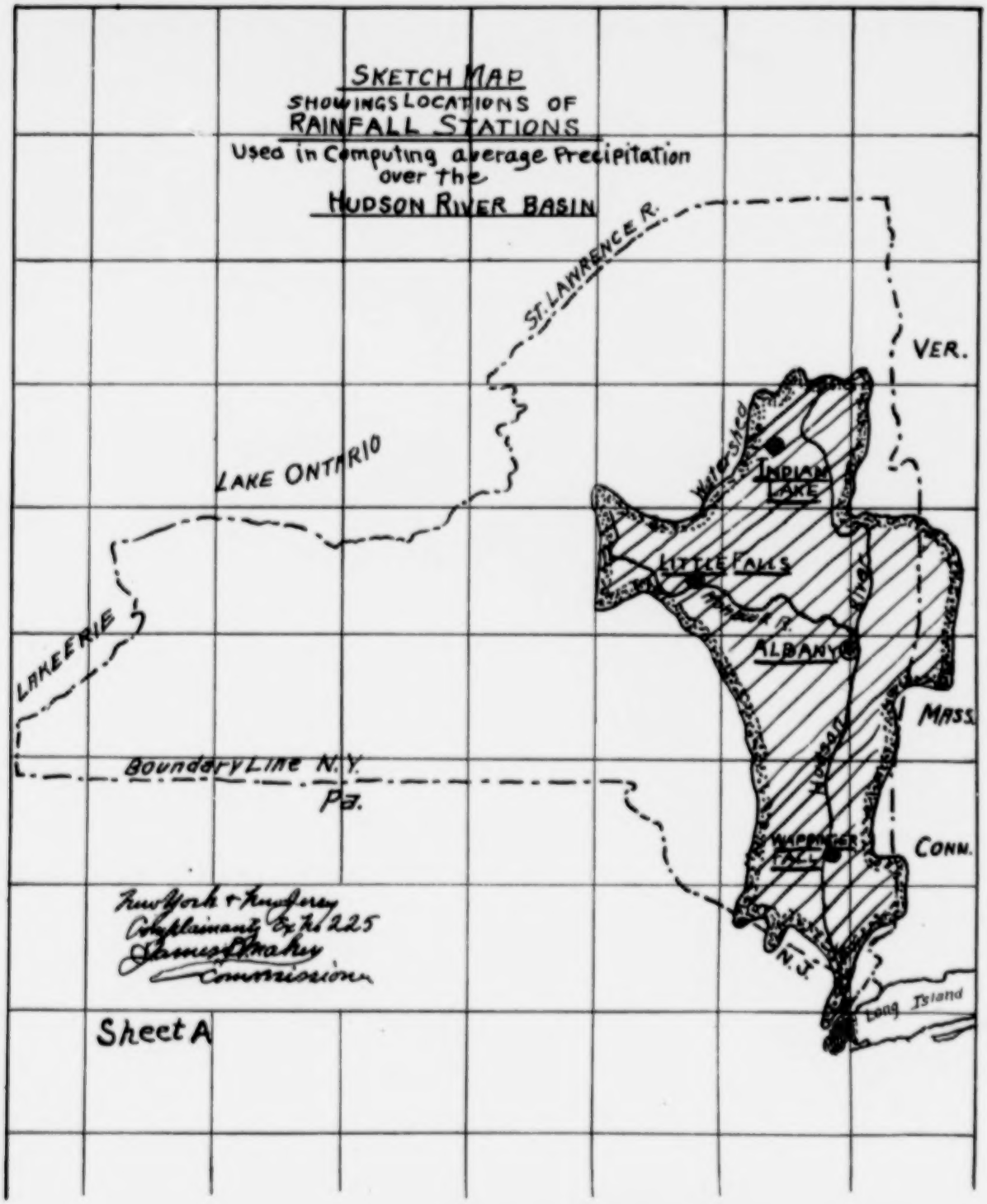
SUBJECT RAINFALL FILE No 2 (11)

HUDSON RIVER BASIN - Monthly Precipitation averaged from ACC. No. 1H315

4 Selected Stations SHEET 2 TOT. IN COMP.

COMPUTED BY GAH CHECKED BY DATE Dec. 7 1911

MADE IN CONNECTION WITH



Subject....RAINFALL-.....File No.....E.....

HUDSON RIVER BASIN-....Monthly Precipitation averaged.....Acc. No.....1H614.....

From 4 selected stations-Means, & for years 1907,1909 & 1911 Sheet..1..Tot. in comp..

Computed by...C.A.H.....Checked by.....Date.....Dec 7,.....1911

Made in connection with

See sheet 2. for sketch showing location of Stations.

PRECIPITATION IN INCHES

YEAR	STATION	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL for YEAR
10 years	Indian Lake	2.89	2.95	3.03	2.76	3.22	4.20	4.07	3.43	3.56	3.49	2.74	3.31	39.65
13 "	Little Falls	2.44	2.42	3.24	2.62	3.41	4.56	4.75	3.67	3.30	3.36	2.73	3.10	39.60
74 "	Albany	2.61	2.47	2.75	2.67	3.50	4.03	4.12	3.82	3.37	3.41	2.97	2.67	38.39
19 "	Wappingers Falls	3.89	4.07	4.04	3.57	4.73	4.45	5.19	4.80	4.02	3.85	3.22	3.87	49.70
Average	Hudson R.Basin	2.96	2.98	3.26	2.90	3.72	4.31	4.53	3.93	3.56	3.53	2.92	3.24	41.84
1907	Indian Lake	4.60	0.93	1.54	3.95	3.35	2.80	2.25	1.45	7.33	4.66	5.90	5.34	44.10
"	Little Falls	3.70	1.11	2.87	3.35	3.52	3.09	4.81	2.97	6.05	3.98	4.33	3.17	42.95
"	Albany	1.71	1.15	0.87	2.33	3.21	3.29	4.14	0.74	5.81	3.71	4.15	2.52	33.63
"	Wappingers Falls	3.68	2.40	1.89	3.14	4.61	5.85	3.24	1.63	8.20	7.47	5.23	4.28	51.62
1907	Hudson R. Basin	3.42	1.40	1.79	3.19	3.67	3.76	3.61	1.70	6.85	4.96	4.90	3.83	43.08
1909	Indian Lake	3.50	6.15	2.55	2.15	2.87	2.20	2.35	2.15	2.00	1.80	2.60	1.72	32.04
"	Little Falls	3.54	5.49	2.65	3.03	3.33	3.56	4.63	2.98	2.21	2.20	2.43	1.68	37.73
"	Albany	3.00	4.00	2.11	2.12	2.72	2.74	1.74	2.42	2.88	0.83	1.04	2.36	27.96
"	Wappingers Falls	4.31	5.62	2.52	5.42	2.63	4.59	2.70	6.47	4.27	1.21	2.29	3.34	45.37
1909	Hudson R.Basin	3.59	5.32	2.46	3.18	2.89	3.27	2.86	3.50	2.84	1.51	2.09	2.27	35.78
1911	Indian Lake	1.22	2.50	2.91	1.12	2.57	3.89	1.15	2.56	2.70	3.35	4.40	3.95	32.32
"	Little Falls	-	1.78	2.62	1.08	1.70	4.94	2.30	3.02	6.25	4.24	1.49	3.22	-
"	Albany	1.56	1.02	2.51	1.15	2.15	4.27	3.16	4.53	2.86	5.00	1.51	2.38	32.10
"	Wappingers Falls	2.67	2.08	2.37	3.67	1.52	4.99	4.62	7.08	3.42	8.64	2.69	1.78	45.53
1911	Hudson R.Basin*	-	1.87	2.60	1.76	1.98	4.52	2.81	4.30	3.81	5.31	2.52	2.83	-

Figures for mean rainfall and for years 1907 and 1909 from Summary of the Climatological Data for the U.S., by Sections. Section 104. Weather Bur.

*--Added by K.Allen, June 17, 1919.

Complainants Exhibit No. 225
Sheet B.

RAINFALL IN HUDSON RIVER BASIN — File 6.5157

Monthly precipitation averaged from four selected stations. — Acc 2264

Computer F.LANG — From — to

Made in connection with — Checker K.A. — Date July 12 1919.

PRECIPITATION IN INCHES

YEAR	STATION	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1908	Indian Lake	2.68	5.65	1.97	3.55	6.10	1.15	3.05	1.70	1.45	2.15	2.13	3.14	34.72
"	Little Falls	1.60	3.09	2.44	2.99	4.52	2.47	3.72	4.81	2.74	2.28	1.83	2.83	35.32
"	Albany	1.36	2.77	1.43	2.62	4.26	2.32	5.33	3.63	0.64	2.07	0.40	1.58	28.41
"	Wappingers Falls	3.00	4.76	4.66	3.77	6.82	3.23	5.97	3.18	1.34	1.11	0.68	3.16	41.68
"	Hudson R.Basin	2.16	4.06	2.63	3.23	5.43	2.29	4.52	3.33	1.54	1.90	1.26	2.68	35.03
1910	Indian Lake	2.74	5.37	2.20	2.68	5.01	3.30	2.90	5.64	4.66	2.00	-	2.90	-
"	Little Falls	4.15	3.85	1.47	2.19	3.51	3.96	2.90	3.04	5.19	1.86	3.08	1.52	36.72
"	Albany	4.13	3.29	0.52	4.19	3.49	2.40	1.28	1.38	3.21	0.87	2.74	1.01	28.51
"	Wappingers Falls	6.06	5.27	1.41	5.29	5.05	5.61	2.77	5.93	3.92	1.03	3.16	2.02	47.52
"	Hudson R.Basin	4.27	4.45	1.40	3.58	4.27	3.82	2.46	4.00	4.25	1.44	-	1.86	
1912	Indian Lake	1.91	2.32	2.15	3.20	4.40	0.42	1.95	3.88	4.60	2.85	4.60	-	
"	Little Falls	1.43	2.48	2.42	3.18	2.94	1.13	1.57	2.04	7.52	3.20	2.57	2.31	32.79
"	Albany	1.10	1.56	3.71	3.31	4.48	0.98	3.13	3.00	3.01	3.37	2.08	2.39	32.12
"	Wappingers Falls	1.75	1.86	4.47	5.29	5.68	1.11	1.36	4.14	3.07	5.78	3.54	4.41	42.46
	Hudson R.Basin	1.55	2.06	3.19	3.75	4.38	0.91	2.00	3.27	4.55	3.80	3.20	-	-
1913	Indian Lake	4.79	1.69	8.32	3.23	3.05	0.48	3.03	1.18	2.77	6.28	3.90	2.30	41.02
"	Little Falls	4.91	1.54	6.09	3.54	3.87	1.53	1.35	2.75	2.26	3.41	3.09	1.29	35.63
"	Albany	2.20	1.64	4.22	1.38	3.29	1.71	1.82	1.14	1.79	4.12	1.48	1.60	26.39
"	Wappingers Falls	4.06	2.85	6.77	6.02	3.41	1.72	1.44	3.93	2.58	8.47	2.99	2.72	46.96
"	Hudson R.Basin	3.99	1.93	6.35	3.54	3.41	1.36	1.91	2.25	2.35	5.57	2.87	1.98	37.50
1914	Indian Lake	3.64	1.90	2.33	5.51	1.43	2.83	3.74	4.82	2.11	1.51	3.53	2.70	26.05
"	Little Falls	1.21	1.75	3.47	3.92	1.61	3.02	2.05	5.09	1.37	1.55	2.01	1.69	28.74
"	Albany	1.91	1.85	3.44	5.78	2.30	1.59	2.25	5.30	0.47	0.84	2.19	1.84	29.76
"	Wappingers Falls	2.93	2.05	2.52	3.89	3.58	2.39	6.14	1.96	0.44	3.90	3.24	3.96	37.00
	Hudson R.Basin	2.42	1.89	2.94	4.78	2.23	2.46	3.55	4.29	1.10	1.95	2.74	2.55	32.89
1915	Indian Lake	3.93	2.31	0.02	0.92	2.79	5.00	6.47	5.32	2.90	3.06	2.64	2.74	38.10
"	Little Falls	3.82	3.82	0.52	1.15	3.56	4.47	7.23	5.48	3.26	3.22	2.33	3.80	42.66
"	Albany	2.76	3.79	0.09	2.15	1.92	2.85	5.05	6.23	2.17	2.15	2.11	6.35	37.62
"	Wappingers Falls	5.89	5.41	0.38	3.23	3.52	2.91	6.25	9.35	2.99	3.00	2.27	8.86	54.06
"	Hudson R.Basin	4.10	3.83	0.25	1.86	2.95	3.81	6.25	6.60	2.83	2.86	2.34	5.44	43.11
1916	Indian Lake	3.14	2.01	2.80	1.61	5.76	3.36	2.84	2.37	4.95	2.82	5.24	3.91	40.81
"	Little Falls	3.42	3.11	3.99	2.55	4.96	4.63	1.78	2.02	5.24	1.71	4.08	3.37	40.86
"	Albany	1.80	3.23	3.99	3.52	2.71	2.24	2.98	2.32	3.96	1.54	2.88	2.70	33.87
"	Wappingers Falls	2.49	6.30	4.70	2.74	3.59	3.60	5.58	3.08	4.72	2.46	2.44	3.80	45.50
"	Hudson R.Basin	2.71	3.66	3.81	2.61	4.26	3.46	3.30	2.45	4.72	2.13	3.66	3.45	40.26

Complainants Exhibit No. 225
Sheet C.

RAINFALL IN HUDSON RIVER Basin — File 6.5157

Monthly precipitation averaged from four selected stations. — Acc 2265

Computer LANG — From — to

Made in connection with — Checker K.A. — Date July 12 1919.

PRECIPITATION IN INCHES

YEAR	STATION	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
1917	Indian Lake	3.56	1.21	2.65	2.65	5.07	7.62	0.94	4.17	1.90	8.33	0.64	2.35	41.09
"	Little Falls	2.47	1.85	3.34	1.27	4.22	9.06	3.98	3.50	2.04	5.64	0.80	2.05	40.22
"	Albany	1.67	2.41	3.14	1.38	2.83	3.00	1.70	2.70	1.36	5.63	0.93	1.91	28.66
"	Wappingers Falls	3.49	3.48	2.84	1.62	4.10	5.13	2.72	4.48	0.70	5.53	0.52	2.60	37.21
"	Hudson R.Basin	2.80	2.24	2.99	1.73	4.06	6.20	2.34	3.71	1.50	6.28	0.72	2.23	36.80
1918	Indian Lake	2.18	4.98	1.62	2.94	4.64	4.77	4.61	1.77	6.92	5.96	-	3.48	-
"	Little Falls	2.51	2.70	1.19	2.55	4.05	4.83	4.35	1.57	4.99	3.62	1.25	1.08	34.69
"	Albany	2.57	1.35	1.89	2.48	2.78	2.30	1.54	3.42	5.37	1.67	2.54	2.15	30.12
"	Wappingers Falls	2.83	4.83	2.29	4.09	3.38	3.82	3.38	1.69	4.85	1.99	2.56	4.62	40.33
"	Hudson R.Basin	2.52	3.47	1.75	3.02	3.71	3.93	3.47	2.11	5.53	3.31	-	2.84	-
	Indian Lake													
	Little Falls													
	Albany													
	Wappingers Falls													
	Hudson R.Basin													
	Indian Lake													
	Little Falls													
	Albany													
	Wappingers Falls													
	Hudson R.Basin													
	Indian Lake													
	Little Falls													
	Albany													
	Wappingers Falls													
	Hudson R.Basin													
	Indian Lake													
	Little Falls													
	Albany													
	Wappingers Falls													
	Hudson R.Basin													
	Indian Lake													
	Little Falls													
	Albany													
	Wappingers Falls													
	Hudson R.Basin													

NEW YORK vs NEW JERSEY, Complainants Exhibit No.225
JAMES D. MAHER Commissioner
Sheet D.

By Dr. O'Sullivan:

Q. What efforts have you made, Mr. Allen, to determine the velocities of these currents of water which you have testified to?

A. We made certain float experiments, which indicated the velocity of the water at different parts of their course, and there was also available a large amount of material published by the United States Coast & Geodetic Survey. From their publications, the velocity of the ebb current of the Narrows is two knots, which equals 3.4 feet per second, at the strength of tide; and on the flood, 1.6 knots, which equals 2.7 feet per second at the strength of tide. The mean velocity of the ebb is 1.22 knots, or 2.1 feet per second, and the mean flood velocity .95 of a knot, which equals 1.6 feet per second. The Hudson River, opposite West 39th Street, has a velocity at strength of tide of three knots, or 5.1 feet per second during the ebb, and 2 knots, or 3.4 feet per second on the flood, and the mean velocity of the ebb is 1.86 knots, or 3.2 feet per second, and on the flood 1.27 knots, or 2.2 feet per second. The East River, opposite East 19th Street, has a velocity at strength of tide on the ebb of 2.6 knots, or 4.4 feet per second, and on the flood, of 2.3 knots, or 3.9 feet per second. The mean velocity is 1.99 knots, or 3.4 feet per second, and on the flood, 1.81 knots, or 3.1 feet per second.

602 In connection with the float experiments, diagrams were prepared showing the course taken by various floats from the vicinity of the proposed outfall of the Passaic Valley Sewer, and published in the 1914 Report of the Metropolitan Sewerage Commission. I have outlined these in red on this exhibit. For instance, on September 28, 1908, a float set adrift at 7.08 o'clock in the morning at this point, went 9.14 miles to a point on the west shore opposite 60th Street, Manhattan, the average velocity being 1.45 miles per hour.

By Mr. Riker:

Q. Mr. Allen, were you in charge of the force, and did they operate under your direction and supervision, in making the various float experimentations that you have alluded to as being published by the Metropolitan Sewerage Commission in 1914?

A. There were two series of float experiments. The first series made in 1907 was before the time I came with the Commission. Those made after 1907 I had personal charge of. The one I have just mentioned was one that I had under my personal direction. The next one was made in 1907.

Dr. O'Sullivan: I offer in evidence the full number of float experimentations that have been plotted, and were published by the Metropolitan Sewerage Commission of New York in 1914, and ask that it be marked as Complainants' Exhibit No. 226.

603 By Mr. Riker:

Q. There is in this offer, Mr. Allen, a considerable amount of reading matter. What did you have to do with that?

A. Nothing directly. I made various reports on which that was based, to the President of the Commission. I did not personally prepare the final report.

Q. How do you know it was based on your reports?

A. There was nothing else to base it on.

Q. How do you know?

A. I made the experiments and the report and I know that no one else did.

Q. So far as you know?

A. So far as I know.

Q. You did not write the reading matter in this exhibit offered?

A. No.

Q. Just what did you do?

A. I made the experiments.

Q. What experiments do you refer to?

A. I made various reports, many reports to the President of the Commission.

Q. When did you commence to make your reports?

A. The first experiments were in 1908.

Q. Made by you?

A. Made by me, and all subsequent ones were made under my direction.

Q. When you say that the first one of 1908 was made by you, what part did you actually take in the making of it?

A. I designed the floats, and the party who did the work reported to me, and I frequently went out on a boat myself. I directed how the floats should be placed, where they should be placed; how they should be located, and in general, how the work should be
604 conducted, and then at the conclusion of the work, the path of the floats was plotted under my direction, and reports were prepared by me on various phases of the subject.

Q. Have you testified in this case before?

A. Yes.

Q. Did not you testify to these float experiments?

A. I do not remember.

Q. Did you take the time at which the floats were put in the water, and the places at which they were put in the water?

A. I was not on the boat always. The work was done under my direction, and I frequently went out, but I was not with them all the time.

Q. Can you take the diagrams, which are a part of this offer, and determine as to which of them you were present at, at the time the float was put in the water?

A. No, I can not.

Q. Were you present when the float was taken out of the water?

A. Frequently.

Q. Can you determine as to the diagrams which are involved in this offer, which were the ones at which you were present when the float was taken out?

A. I think by looking at the records I could determine that, for I made a weekly report to the President of the Commission, stating

what I had done every day. I think I could testify that if I had the opportunity of looking over those old records.

Q. You can not now testify today, can you?

605 A. I can not now.

Q. I notice that on page 27 of this offer, there is a red line placed around one of the diagrams. Did you do that?

A. Yes.

Q. Why did you do that?

A. To select—I selected certain of those diagrams which I thought would pertain more particularly to this case, and I had thought first of putting them in as an exhibit by themselves, but it was decided better to put in the whole pamphlet.

Q. Now, taking the one on page 27, on which a red line has been described: It is marked "Float 34, September 26, 1908." Were you present when the float was put in the water?

A. I do not know.

Q. Were you present when the float was taken out of the water?

A. I do not know.

Q. Do you know the length of time, of your own knowledge, that the float was actually in the water?

A. If I was not there, I did not note the time.

Q. Then you were not there?

A. I do not know.

Q. You do not know whether you were there?

A. No.

Q. How do you know whether it represents any actual fact?

A. I do not think anyone can testify to a fact unless he was present.

Q. That is what I want to know. So that, as far as your knowledge is concerned, it is a diagram and nothing more, is it not?

606 A. No. I would say it is a diagram in which I have perfect confidence of its correctness.

Q. Now, on page 28 of the offer, I observe another diagram around which a red line has been described, the diagram being marked "Float E, March 5, 1907." Were you present when the float was put in the water?

A. No.

Q. Were you present when the float was taken out of the water?

A. No.

Q. Do you know how long, of your own knowledge, how long the float was in the water?

A. No.

Q. As a matter of fact, the diagram represents alleged facts which were alleged to have been ascertained before you had anything to do with this work at all?

A. Yes.

Q. And you have no knowledge of your own regard, of whether it correctly represents anything?

A. No.

Q. And on page 29, I observe another one with a red line described about it marked "Float X, July 17, 1907." That was also before your time, was it not?

A. Yes.

Q. You have no knowledge in regard to this matter?

A. No.

Q. On page 31, however, there is another one, a red line designated the diagram marked "Float 28, September 16, 1908." That was after you came in connection with the matter?

A. Yes.

Q. Did you put the float in the water on that occasion?

A. I do not know.

607 Q. Did you take it up?

A. I do not know.

Q. You do not know anything about it?

A. I know it was done under my direction, and I have faith in its correctness.

Q. That is all you do know, that it was reported to you as something that was done?

A. Yes.

Q. On the preceding page, page 30, there is another one, with a red line described about it, "October 1, 1908, Float 37." Have you any recollection of any facts that were ascertained by you in connection with that diagram?

A. Nothing particular.

Q. And so on throughout this offer, as to all of the diagrams which have been marked with a red line, is there any one of them as to which you can say you ascertain any fact which purports to be represented graphically by the diagram?

A. I do not know of any particular one I could be sure I was observing personally.

Q. Is that true of the diagrams which are not marked with the red line, the same thing?

A. Yes.

Q. Under whose supervision and direction was this work done, Mr. Allen?

A. Under mine.

Q. Have you read this report?

A. Yes.

Q. Where it says "Those engaged upon this work, which was done under the direction of the President, were Ernest F. Robinson, Herbert W. Harvey, and Homer Calver." Were you the President?

A. What page is that?

608 Q. Page 4, the last paragraph on page 4, "The survey party consisted of two, and at times three assistants. Those engaged upon this work, which was work done under the direction of the President, were"—were you the President?

A. No.

Q. Is that statement in accordance with your understanding of the facts?

A. Ernest F. Robinson was not engaged on that work. He was not on the work at that time. Referring to the 1913 experiments, that was something special. I would like to qualify what I said before. There were some experiments made in the Lower Bay with reference to the establishment of an island for sewage disposal shown

PRELIMINARY REPORTS

ON THE

DISPOSAL OF NEW YORK'S SEWAGE

VIII

TIDAL CURRENTS IN NEW YORK HARBOR AS SHOWN BY FLOATS*

METROPOLITAN SEWERAGE COMMISSION
OF NEW YORK

GEORGE A. SOPER
JAMES H. FUERTES
H. de B. PARSONS
CHARLES SOOYSMITH
LINSLY R. WILLIAMS
Commissioners

OCTOBER, 1913.

*This report is issued in advance of the final report of the Metropolitan Sewerage Commission in order that the contents may be of early service. Some features of this report will remain open for revision until the final report is submitted.

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THE FLOAT RECORDS

intervals and plot the positions upon a standard chart of the U. S. Coast and Geodetic Survey.

Floats

The typical float used in the observations of 1913 was similar to the spar float described in the report of 1910. It is shown in Fig. 2. The stem was a piece of 4-inch by 4-inch timber, 6 feet long, around the upper end of which was built the float proper—a block of wood 12 inches by 12 inches by 24 inches. On the lower end of the stem were 4 vanes 21 inches by 18 inches, placed at right angle with one another and made of No. 14 gauge sheet iron. A ⅜-inch rod for carrying a flag by day or lanterns by night projected about 3½ feet above the top of the float; it was supported at its middle point by a frame of four ⅛-inch by 2-inch flat bars. At the top of this frame were placed two 3-inch rings for convenience in catching the float when removing it from the water.

This float, when in use, was submerged so that the top was about even with the surface of the water. No effect was observable from the wind. The flag and iron frame may have caught some wind, but not enough to appreciably affect the course of the float. When the wind was very fresh the boat was obliged to quit work on account of the seas, for which reason the float was never subjected to heavy wind pressure such as might have altered its course. It was noticed that floating objects which happened to be within view, such as blocks of wood, were easily driven by the wind, as was the steamer, while the float often traveled in an opposite direction.

The flag carried by the float was square, diagonally divided into red and white, and was plainly visible at distances of a quarter of a mile or more. No difficulty was ever experienced in finding the float. All the observations were made during daylight hours. The flags carried by the float and attending observation steamer were always scrupulously respected by passing vessels, most of the large ocean liners slowing down or stopping their engines in passing. The number of ships which showed the work this courtesy was large, most of the observations being carried on in the most frequented channel between New York harbor and the open ocean.

None of the floats approached the shore, or grounded or went into inaccessible places. They were never injured by vessels and throughout the work no repairs were required beyond an occasional straightening of the flag rod at the top, due to accidents in handling.

Can floats were used for a part of the time to determine the trend of currents at other depths than indicated by the wooden floats. The construction of the can floats has been shown in the 1910 report of the commission. Fig. 2, page 4, shows the design and dimensions of both spar and can floats.

The can float was in two parts connected by wire, whose length could be regulated so as to suit the depth of water under observation. One can floated at the surface and supported the other can. Each was filled with sand and water sufficiently to be submerged. The can floats were not found serviceable in the rough water of Lower New York bay. The choppy seas would raise and lower the upper can, while the lower can could not accommodate itself to these sudden motions. The result was a series of jerks upon the connecting wire which tore out the fastenings. Occasionally the can floats grounded unexpectedly or dragged upon the bottom.

By watching for favorable opportunities some observations of interest were made by means of the can floats in spite of the shortcomings which have been mentioned.

Unsuccessful Attempts to Use Current Meters

Efforts were made to use current meters to determine the force and direction of currents at different depths at the site of the proposed island and elsewhere, but this undertaking was not successful, owing, apparently, to the difficulties of insulation brought about by salt water conditions.

The efforts extended over the period between August 18 and September 3, 1913. Two current meters were obtained by loan through the courtesy of the Dock Department of the City of New York, one being of the Ellis type and the other of the large Price type. The engineers of the Dock Department had been unable to obtain satisfactory results from their use.

The meters were thoroughly overhauled and some changes made in their insulation in order to avoid the difficulties anticipated. Preliminary to making observations, the meters were carefully rated. For this purpose a course of 600 feet was laid off along the bulkhead in Sheepshead bay and ranges at right angles at the ends and center of this course were set up. The meters were placed at the lower ends of two vertical spars, one rigged over each bow and far enough outboard to clear the bow wave. The spars were braced and guyed so as to maintain a vertical position and keep the meters submerged about 1½ feet.

The electrical connections were led inboard to a pair of telephone head receivers, one for each meter, which carried the grating sound of the contact of each revolution of the meter wheel to the ear of the observer. The number of revolutions which occurred at various speeds of the boat when passing over the measured course were counted and the time determined by stop-watches. The revolutions of time were reduced to revolutions per second and the speed of the boat reduced to feet per second. Upon a sheet of cross-section paper the feet per second were then plotted as abscissas and the corresponding revolutions per second as ordinates. The points plotted at the inter-

section of these co-ordinates lay close to a straight line. This was the rating curve of the meter.

It was intended that the meters should be observed by lowering them just below the surface of the water in the time taken for 10 revolutions. For bottom velocities the meter was to be lowered to the bottom and then raised a foot when a second reading was taken. Mid-depth reading was also to be obtained.

Trouble with the insulation occurred with both meters, but the Price meter seemed to be the stronger and more serviceable of the two and was more easily examined and repaired. In the Ellis meter the trouble from insulation was due largely to the fact that sea water would enter the contact chamber, displacing the paraffine oil with which it was filled, and short-circuit the meter. The entrance was effected around the axle, where it entered the contact box, there being considerable play at this point. The fine wire spring, upon which the contact depended, seemed subject to some electrolytic action by which it was eaten away, necessitating frequent renewals with copper wire. In spite of every effort which could be made, this difficulty could not be overcome. Continual repairing was necessary and fully 75 per cent. of the time was occupied in this work. It was impossible to determine what observations were accurate.

The Price meter gave trouble at first, owing to faulty insulation where the wire entered the contact chamber. The whole connection was finally covered bodily with paraffine, held in place by rubber insulating tape. The contact apparatus itself gave no trouble, when the chamber was kept filled with paraffine oil.

The chief difficulty with the Price meter occurred in the wire cable which was used to suspend the apparatus and carry the sound of the revolutions to the observer's ear. The cable stretched and opened up the insulation. This difficulty might have been overcome by providing a different method of suspension, but the prospect of further difficulties prevented this change being made.

In all, five attempts were made to secure observations for a complete tidal cycle. In only one case, that of August 29, was a record of any considerable duration obtained. This extended from 7:20 A. M. to 3:00 P. M., interrupted by frequent breakdowns. The observers were uncertain of the results. Short circuits, such as were continually occurring, produced in the head receivers a noise so closely resembling that of a contact of the meter that confusion resulted. The work was discontinued owing to the unreliability of the results and the probability that a large amount of time would necessarily be consumed in adjusting the meters to the work.

To obtain satisfactory results with current meters in such work as that contemplated new instruments should be provided, preferably of large Price type. Suitable changes should be made in the insulation to fit them for salt water; special cables

should be provided for the suspensions and each observer should be supplied with a kit of proper tools and equipment for making hasty repairs in the field.

Collection of Data

As far as practicable the observations were begun just before the beginning of an ebb or flood current and continued throughout the succeeding flow of tide. As soon as the float was set adrift it was located by two sextant angles read from the steamer to three of the various lighthouses in the vicinity of the Lower bay. At intervals of half an hour, or 15 minutes near slack water, the steamer was run alongside the float and the location again determined, until the final location at the end of the observations, when the float was taken up.

Most of the courses started from the site of the proposed outlet island, whose location had been fixed from soundings on the Coast Survey charts. This location was determined in the field by trial, reading sextant angles from various positions of the boat until when plotted they indicated the required point. Ranges were then fixed in order that the point might readily be found again.

A tall stack on Sandy Hook was found to be on line with a notch in the skyline of Atlantic Highlands and, similarly, Norton's Point was on a line with a break in the skyline of Staten Island.

Through the courtesy of Col. S. W. Roessler, Corps of Engineers, U. S. A., a tripod was located as near the site of the proposed island as practicable by Mr. G. E. Balch, U. S. Assistant Engineer in charge of the Hydrographic Survey of the U. S. Engineer Corps in this vicinity. On attempting to locate the tripod at the site proposed it was found that the depth of water was somewhat in excess of that shown on the chart, so that the tripod could not conveniently be fixed exactly in the desired position. It was finally placed about 1,400 feet southwest of the proposed site in 13 feet of water at mean low tide. The Coast Survey chart shows a depth of 10 feet at this point. The tripod was constructed of 4-inch gas pipe and stood 36 feet high, about half this height being submerged.

The work was directed from the office in accordance with information mailed to headquarters at the close of each day's run. For this purpose an approximate drawing of the course last observed was made upon a small white print of the Lower bay with a scale of 1 to 80,000 and sent by mail. This sheet, in addition to recording the approximate path of the float, contained such information regarding the wind and weather conditions, hours of observation and tidal actions as might be necessary for a correct understanding of the work. On those occasions when the conditions were not favorable for observations the observers reported at the office for instructions.

Plotting the Data

The path followed by a float was laid down upon charts traced from the U. S. Coast and Geodetic Survey charts. The observations of the floats which were made at intervals of half an hour or more frequently permitted a series of points to be plotted, and when these were connected the path of the float was considered to have been determined.

Two sextant angles had been read in quick succession to three prominent landmarks whose position was located on the chart. In plotting the position of the float, the two adjacent angles were laid out on a piece of tracing cloth and this was shifted upon the chart until the three lines passed through the three station points. The intersection of the angles was then pricked through to the chart. The chart upon which the plotting was done had a scale of 1 to 40,000. Confusion among courses was avoided by using a fresh chart after three or four days' work.

The charts with the paths of the floats carefully plotted thereon were delivered at the commission's office and the records were transferred to separate sheets for reproduction.

There was determined for each float the total time and distance traveled, the average velocity and maximum velocity. The most important information was obtained from a study of the path itself. This was accepted as showing the trend of the main surface currents at the times and under the circumstances which occurred. In the cuts accompanying this report will be found all the essential data represented in graphic form.

Results

Twenty-five spar float observations were made in 1913. They were all made, entirely or in part, in Lower New York bay. They were begun on June 9, 1913, and finished August 25, 1913. The total number of hours worked was 341. From the beginning until about June 25 observations were made daily. Later, in order to obtain longer records, two days' work were concentrated in one, the work continuing through a complete tidal cycle when the conditions permitted. Interruptions to long-continued observations were frequent because of the scarcity of days upon which three successive slack waters occurred during daylight hours and because of fog and wind which not infrequently cut short or prevented observations being made after the party had been assembled and reached the point in the boat from which observations were to begin. The longest series of observations lasted 16 hours. They were on June 26 and July 22. There were 10 series of observations continued for 12 hours or more.

Of the 25 series of observations, two were made solely with a view to determine the time of slack water at the site of the proposed island as compared with the time of high

and low water at Sandy Hook, and were not productive of any information as to the trend of the currents. Four others were cut short by fog, heavy weather or other unfavorable conditions; of these 3 did not progress far enough to afford useful information. There were thus left about 20 records capable of affording useful data.

The most striking characteristic of the records, considered as a whole, is the fact that the currents in the middle of Lower New York bay run parallel to the Ambrose channel and follow its turns at the upper end. This fact is established by a number of float records and is controverted by none. Another salient characteristic of the float paths is their avoidance of Jamaica bay and Coney island channel. A float carried well into the bight of Gravesend bay on the flood tide would return into the main channel and go down Ambrose channel instead of floating ashore on Coney island or following along the Coney island channel. This was undoubtedly due to the effect of the water in the tidal prism leaving Gravesend bay.

A tendency to continue down the old Main Ship channel instead of turning out to sea through Ambrose channel was marked in some floats leaving the Narrows. These floats were all halted by slack water near West Bank or Romer Shoals lighthouses. Other floats dropped at these points on the first of the flood, either turning north toward the Narrows or went into Raritan bay. In the former case they were likely to turn near Swinburne or Hoffman island and go out by Ambrose channel or return to West Bank light. In the latter case, a float would go into Raritan bay only to Old Orchard light or a little further and return on the next ebb current. One float released off Sandy Hook at slack water went almost due west for about four miles on the flood current and then returned to a point near the starting place.

Floats which were set adrift near Rockaway inlet bell buoy passed the inlet, showing no tendency to enter either on the flood or on the returning ebb current. Furthermore, floats carried out to sea on the ebb current in a line parallel to Ambrose channel returned in the same line, showing no tendency to move toward Rockaway beach or inlet.

The greatest distances traveled from the site of the proposed island on the flood and ebb currents respectively were to the Narrows and to Ambrose channel lightship when the start was made from the site at slack water. A float reaching the Narrows and returning parallel to Ambrose channel was carried further out than the starting point, and floats carried to sea, beyond the whistling buoy, never reached the entrance to Ambrose channel on the return flood tide.

From observations made with can floats it appeared that the deeper currents traveled more slowly than the currents near the surface and that the currents at the very top of the water moved more rapidly than any others. The difference was least between

the route followed by the shallow can float and that of the wooden spar float, the difference amounting to 150 feet in 30 minutes. The deep can float lagged behind the wooden spar float between 800 and 1,000 feet in the same time.

Conclusions

Among the most important inferences to be drawn from the observations of spar floats in the Lower New York bay in the summer 1913 are the following:

1. The shores of Lower New York bay would be in no danger of pollution if sewage was to be discharged at the site of the proposed island.

2. On flood currents floating sewage would seldom, if ever, reach the Narrows and would not pass into the Upper bay.

3. There is no set of tidal water capable of carrying sewage from the site of the proposed island toward Rockaway beach or inlet nor towards Coney island on flood or ebb currents.

4. There is a resultant motion seaward from the vicinity of the proposed island and particles carried out to the whistling buoy or further will not return.

5. Floating particles will be repelled from Gravesend bay.

6. Little sewage, if any, will cross Ambrose channel, and that which does cross will proceed outward from the Narrows on the ebb current and will have a tendency to return by the same route.

7. The proportion of sewage from the island which is capable of reaching Raritan bay is small and has no tendency to remain in the bay.

Tidal Currents in New York Harbor as Shown by Floats

RECORDS OF OBSERVATIONS FROM 1907 TO 1913, INCLUSIVE

Observations of harbor currents, as shown by floats, were described in the report of this commission dated April 30, 1910, Chapter IV, page 183, *et seq.*, and further studies in this direction were made in 1913. The object of the new work was to obtain knowledge of the currents in Lower New York bay, the immediate point of interest being the transporting effects to be expected upon the discharge of sewage from the proposed outlet island located about midway between Sandy Hook and Rockaway Point. The site of the island, the main channels and various lighthouses and buoys mentioned here are shown in Fig. 1.

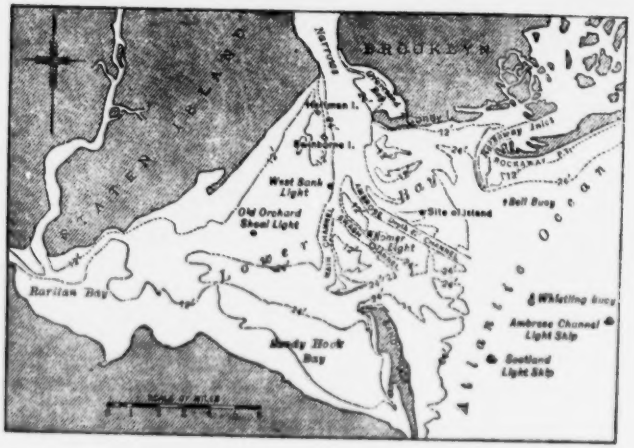


FIG. 1

In the report of 1910, the method of work done up to that time was described and the principal results of the float experiments were set forth. A large number of float observations which had been made at the time the 1910 report was prepared could not be given in detail and it has remained for the present to record these in their proper form.

Scope of Work

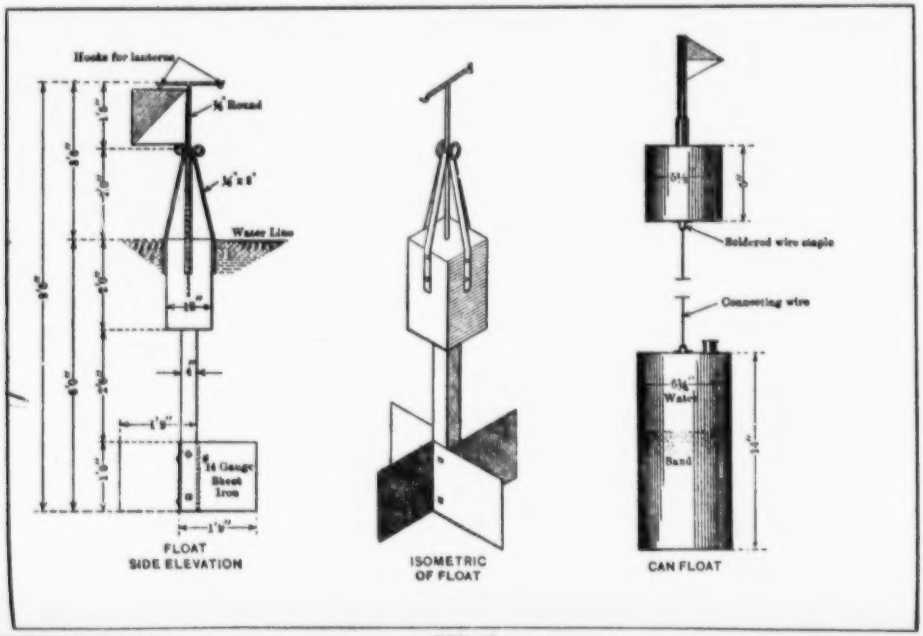
There are here described in the form of cuts all the float records made by the commission from 1907 to 1913. Each cut is a photographic reproduction of a carefully made outline map of the part of the harbor where the observations were carried on, with the path of the float and the essential data relating thereto plotted upon the map.

METHOD OF WORK IN 1913

The observations were made from a boat chartered for the purpose. This boat was 62 feet long, 16-foot beam and drew 5 feet of water. Her tonnage was about 40 and she was propelled by a 30-h.p. steam engine; her speed averaged about 8 miles per hour. The boat carried a red flag, which proved an effective means of warning off traffic. The crew consisted of a captain, engineer and deckhand.

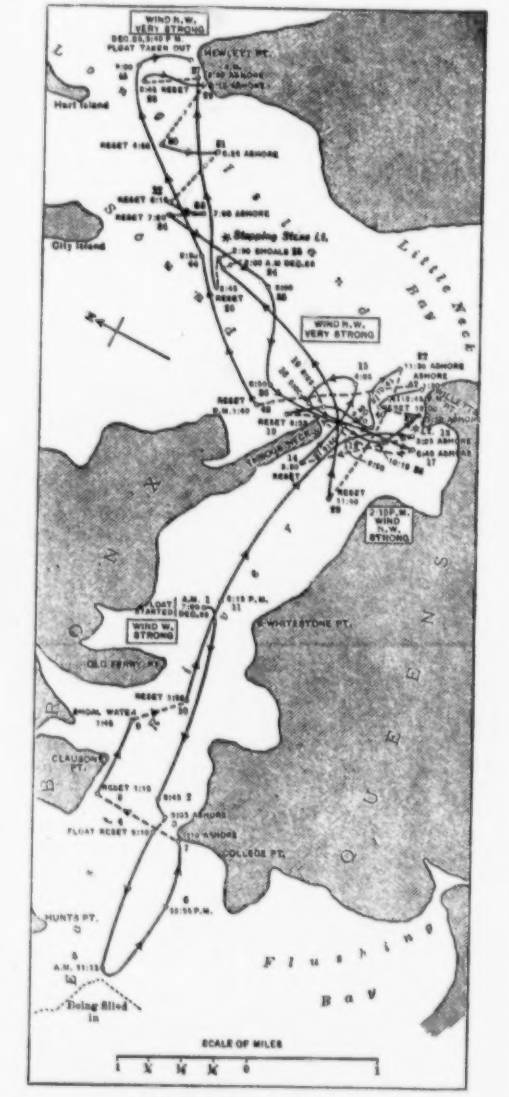
This steamer served its purpose acceptably. A large, open, forward deck covered by an awning afforded a convenient place for handling the floats and making the observations, while an unused galley under the pilot house afforded place for storage of instruments and equipment and permitted the setting up of a drawing board where the observations could be plotted. In a heavy sea or ground-swell the steamer rolled considerably, a tendency which was aggravated when drifting near the float. There were comparatively few occasions when the sea was too rough for operations.

The survey party consisted of two, and, at times, three assistants. Those engaged upon this work, which was done under the direction of the President, were Ernest F. Robinson, Herbert W. Harvey and Homer Calver. Their duty was to follow the course of the float, guard it from injury by passing vessels, determine its position at frequent



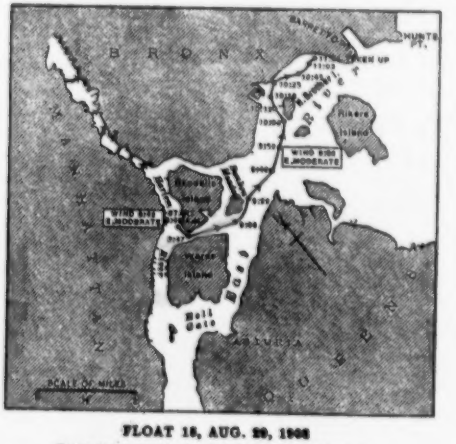
FLOAT 60, DEC. 14-15, 1909

Total distance, flood, = 14.42 miles in 16.66 hours
Average velocity .... = 0.84 miles per hour
Maximum " .... = 2.00 " " "



FLOAT 64, DEC. 22-23, 1909

Total distance, flood, = 12.2 miles in 18.5 hours
Average velocity .... = 0.85 miles per hour
Maximum " .... = 2.22 " " "
Total distance, ebb, = 8.53 miles in 14.33 hours
Average velocity .... = 0.60 miles per hour
Maximum " .... = 1.16 " " "



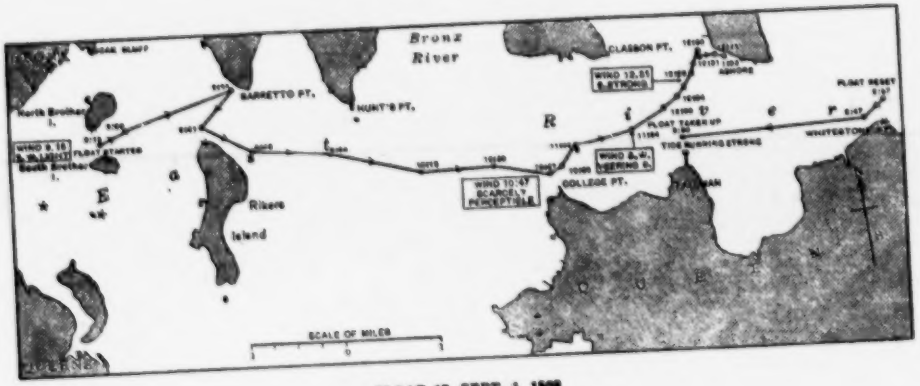
FLOAT 18, AUG. 20, 1908

Total distance, flood, = 2.87 miles in 2.33 hours
Average velocity .... = 1.21 miles per hour
Maximum " .... = 2.56 " " "

Paths of Floats in the East River

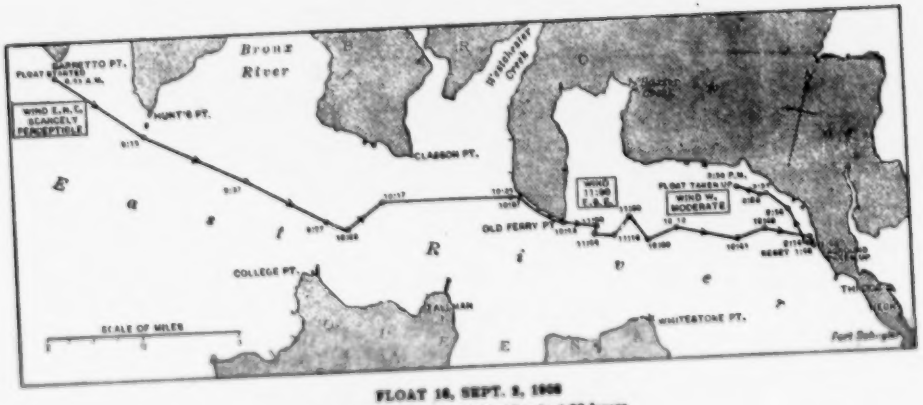
FLOAT 19, SEPT. 2, 1908

Total distance, flood, = 2.96 miles in 4.07 hours
Average velocity .... = 0.72 miles per hour
Maximum " .... = 1.51 " " "



FLOAT 17, SEPT. 1, 1908

Total distance, flood, = 4.14 miles in 3.8 hours
Average velocity .... = 1.09 miles per hour
Maximum " .... = 2.60 " " "



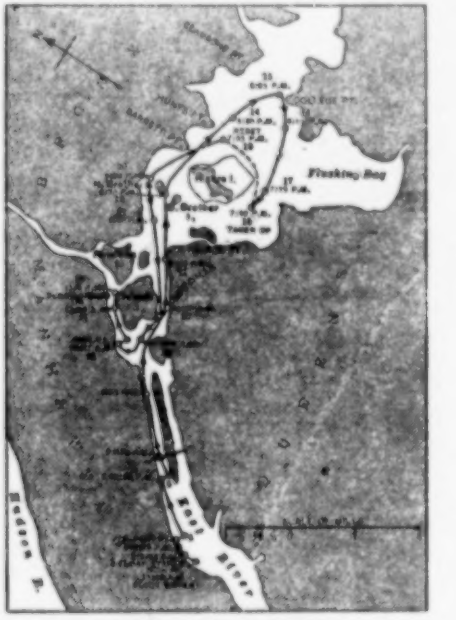
FLOAT 18, SEPT. 2, 1908

Total distance, flood, = 4.41 miles in 4.92 hours
Average velocity .... = 0.9 miles per hour
Maximum " .... = 1.65 " " "

Paths of Floats in the East River

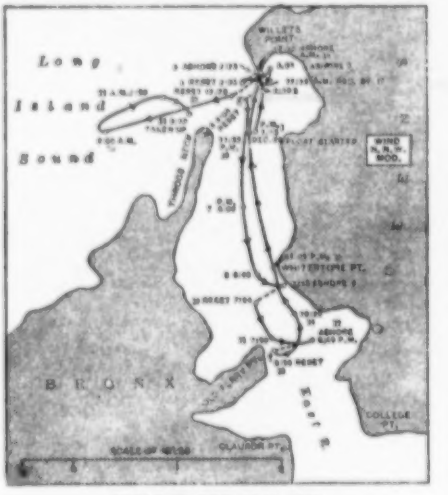
FLOAT 68, DEC. 21, 1909

Total distance, flood, =7.24 miles in 5.0 hours
Average velocity.... =1.45 miles per hour
Maximum " .... =2.55 " " "
Total distance, ebb, =6.09 miles in 6.17 hours
Average velocity.... =0.97 miles per hour
Maximum " .... =1.28 " " "



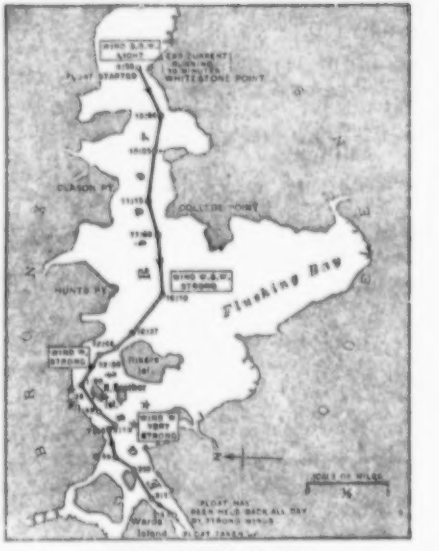
FLOAT 52, NOV. 22-23, 1909

Total distance, flood, =8.21 miles in 6.67 hours
Average velocity.... =1.65 miles per hour
Maximum " .... =4.13 " " "
Total distance, ebb, =6.31 miles in 6.97 hours
Average velocity.... =0.93 miles per hour
Maximum " .... =2.66 " " "



FLOAT 62, DEC. 20-21, 1909

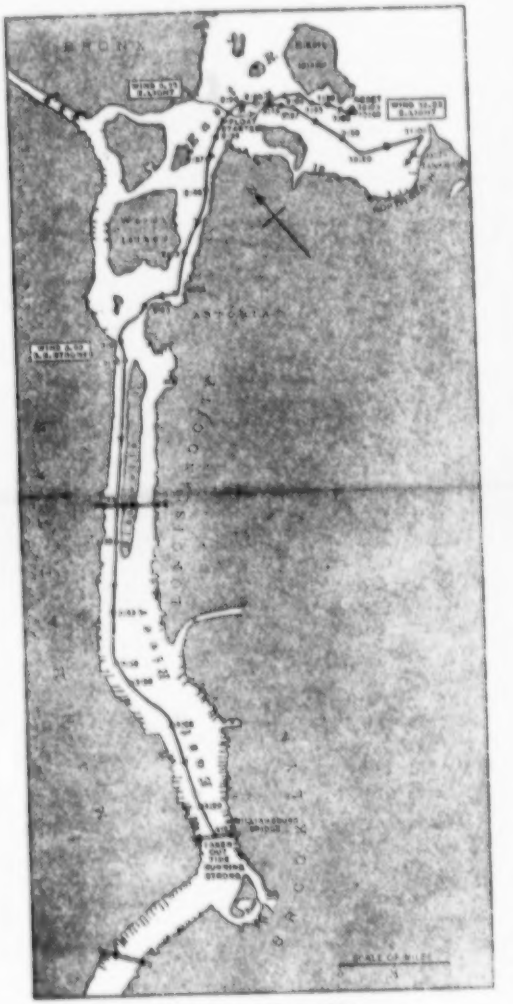
Total distance, flood, =5.40 miles in 7.33 hours
Average velocity.... =0.74 miles per hour
Maximum " .... =1.65 " " "
Total distance, ebb, =4.0 miles in 5.75 hours
Average velocity.... =0.70 miles per hour
Maximum " .... =0.97 " " "



FLOAT 26, SEPT. 10, 1908

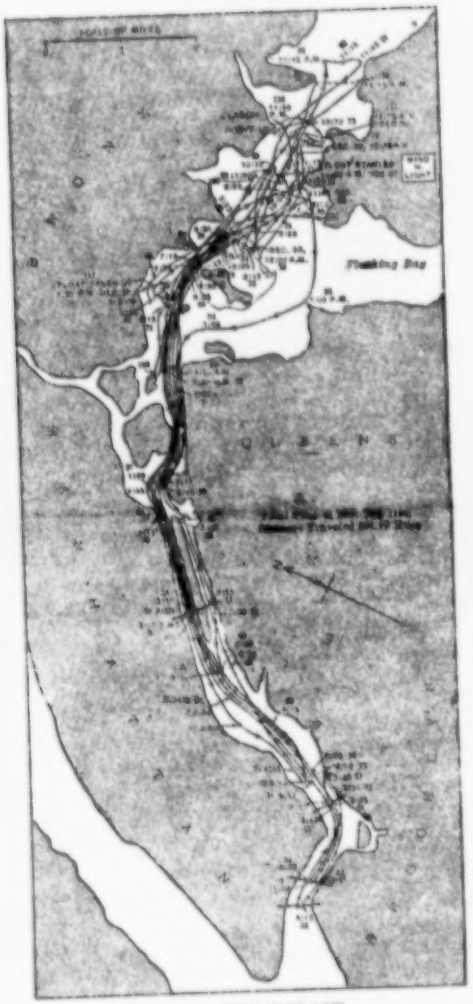
Total distance, ebb, =6.68 miles in 5.00 hours
Average velocity.... =1.18 miles per hour
Maximum " .... =1.96 " " "

Paths of Floats in the East River



FLOAT 14, AUG. 21, 1908

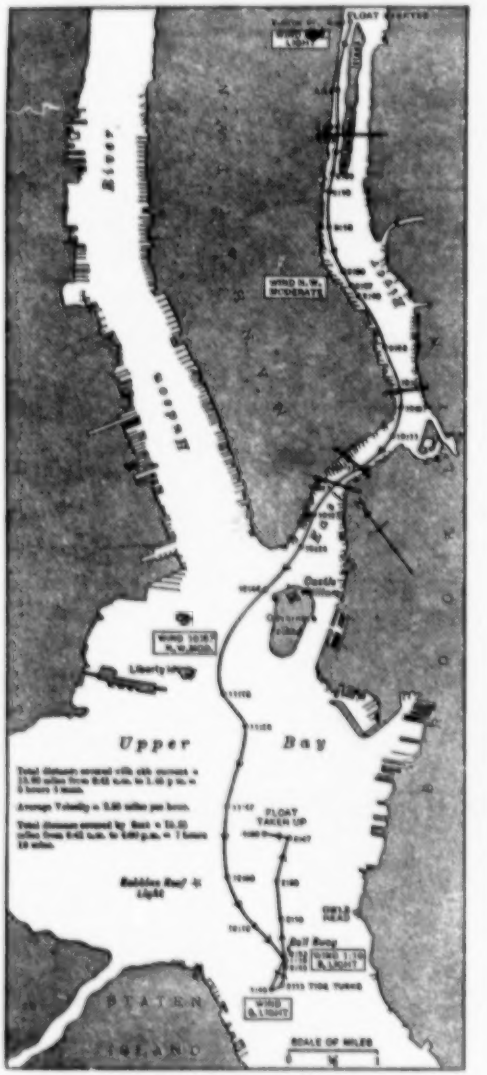
Total distance, ebb, = 4.71 miles in 3.75 hours
Average velocity .... = 1.26 miles per hour
Maximum " .... = 2.52 " " "



FLOAT 48, DEC. 27-28, 1909

Total distance, flood, = 51.88 miles in 27.25 hours
Average velocity .... = 1.89 miles per hour
Maximum " .... = 3.00 " " "
Total distance, ebb, = 55.92 miles in 41.35 hours
Average velocity .... = 1.35 miles per hour
Maximum " .... = 3.37 " " "

Paths of Floats in the East River

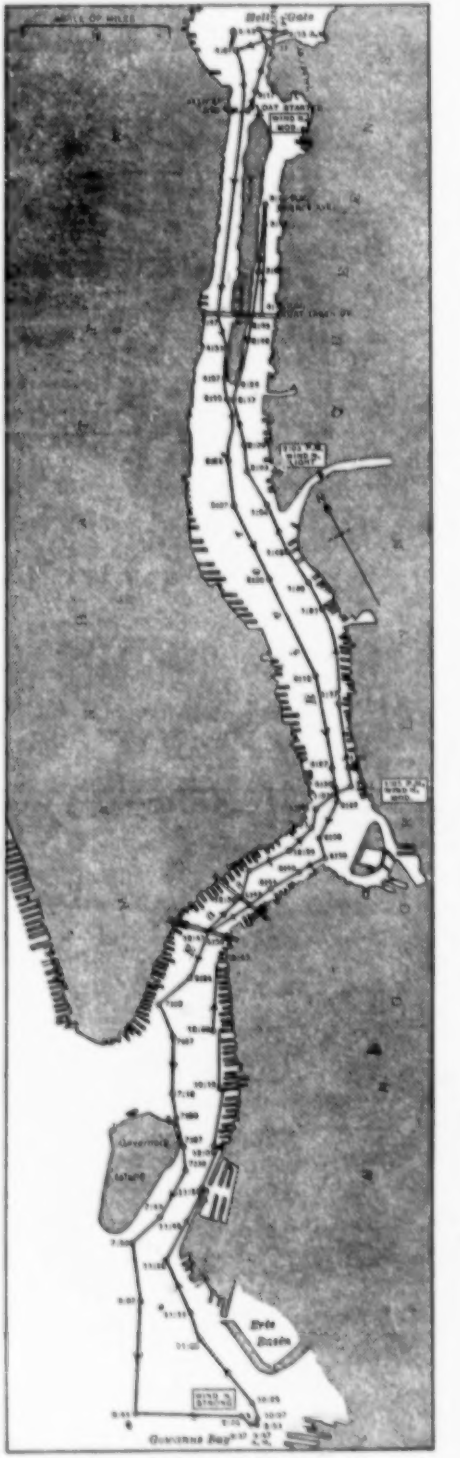


FLOAT 33, SEPT. 8, 1908

Total distance, flood, = 2.35 miles in 2.25 hours
Average velocity.... = 1.0 mile per hour
Maximum " .... = 1.8 miles " "
Ebb, maximum velocity..... = 2.5 " " "

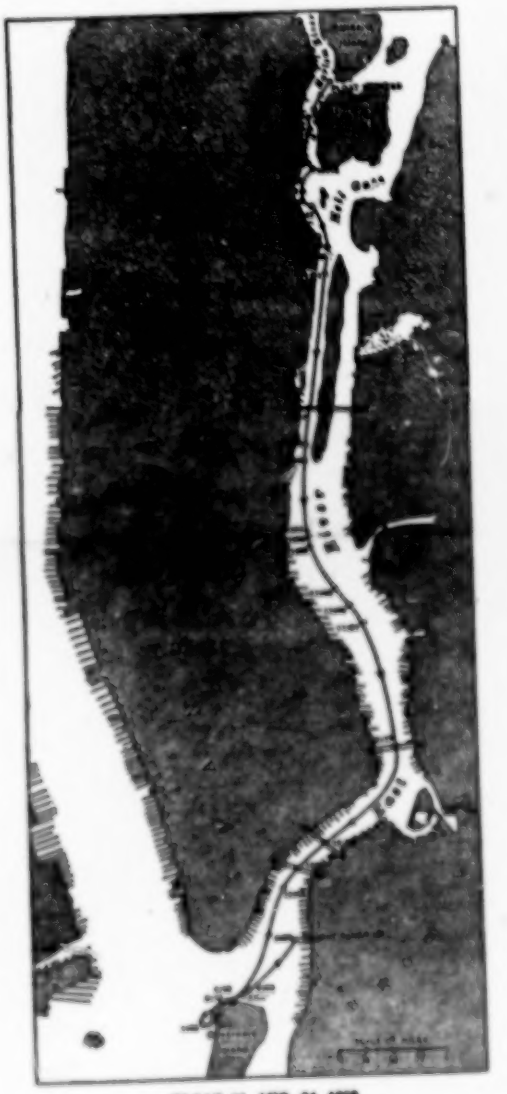
FLOAT 38

Total distance, flood, = 6.80 miles in 4.92 hours
Average velocity.... = 1.49 miles per hour
Maximum " .... = 7.20 " " "
Total distance, ebb, = 11.06 miles in 8.7 hours
Average velocity.... = 1.96 miles per hour
Maximum " .... = 5.70 " " "



FLOAT 38, OCT. 2, 1908

Paths of Floats in the East River and Upper Bay



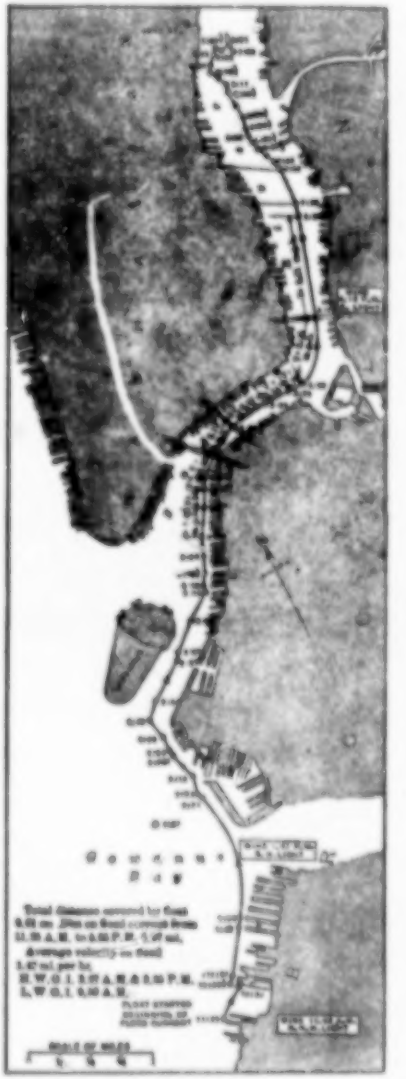
FLOAT 10, AUG. 24, 1908

Total distance, ebb, =[illegible] miles in [illegible] hours
Average velocity .... =[illegible] miles per hour
Maximum " .... =[illegible] " " "

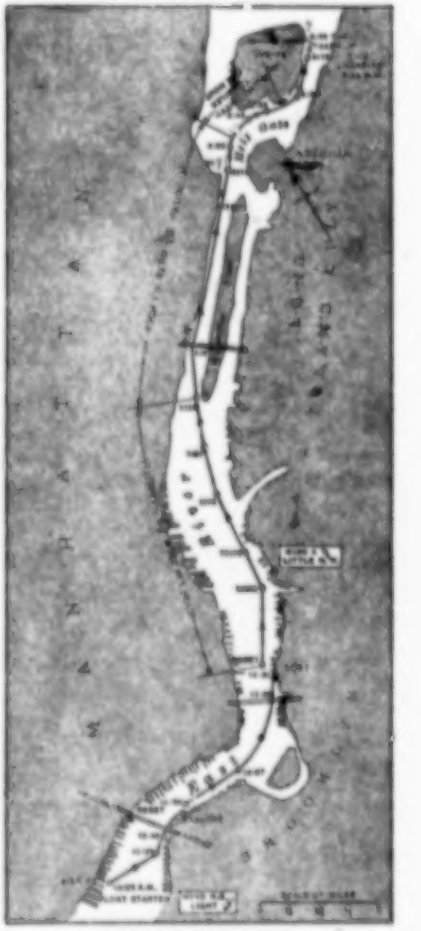
FLOAT 27, SEPT. 12, 1908

Total distance, flood, =[illegible] miles in [illegible] hours
Average velocity .... =[illegible] miles per hour
Maximum " .... =[illegible] " " "
Total distance, ebb, =[illegible] miles in [illegible] hours
Average velocity .... =[illegible] miles per hour
Maximum " .... =[illegible] " " "

Paths of Floats in the East River and Upper Bay

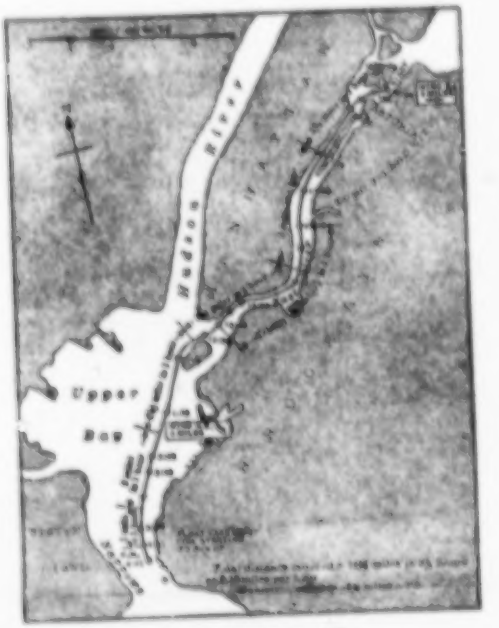


FLOAT 30, OCT. 5, 1906
Maximum velocity, flood, =2.97 miles per hour

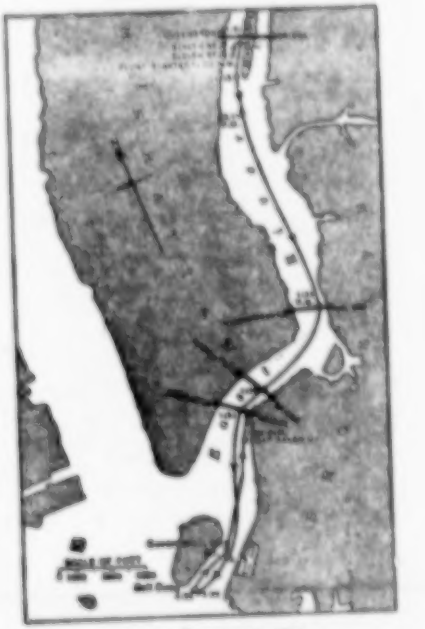


FLOAT 9, MAR. 7, 1907
Total distance, flood, =8.6 miles in 4.78 hours
Average velocity ..... =1.87 miles per hour
Maximum " ..... =2.6 " "

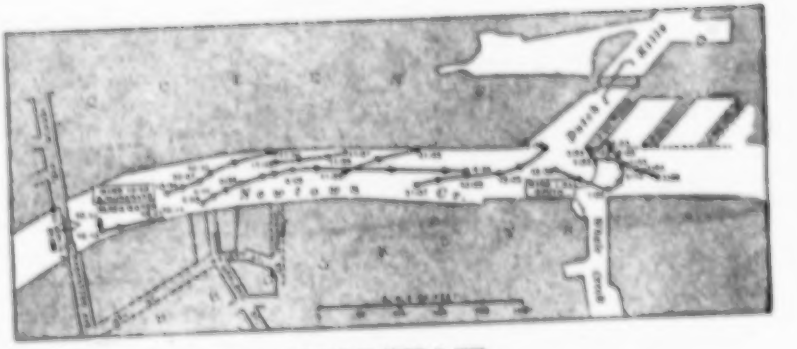
Paths of Floats in the East River and Upper Bay



FLOAT 1, MAR. 25, 1907
Average velocity, ebb, =2.10 miles per hour

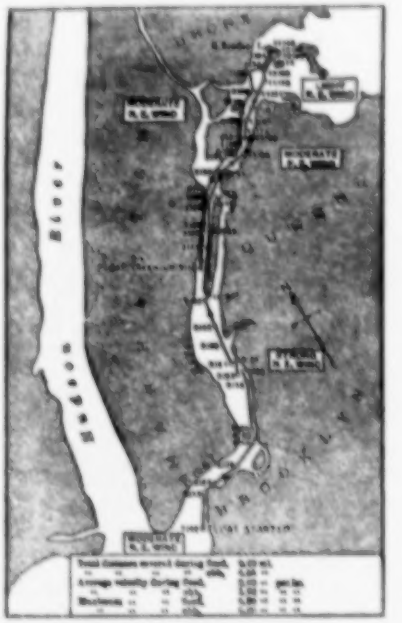


FLOAT 48, NOV. 16, 1909
Total distance, flood, =2.10 miles in 3.07 hours
Average velocity ..... =0.61 miles per hour
Maximum " ..... =2.00 " " "
Total distance, ebb, =4.00 miles in 4.83 hours
Average velocity ..... =1.61 miles per hour
Maximum " ..... =4.00 " " "

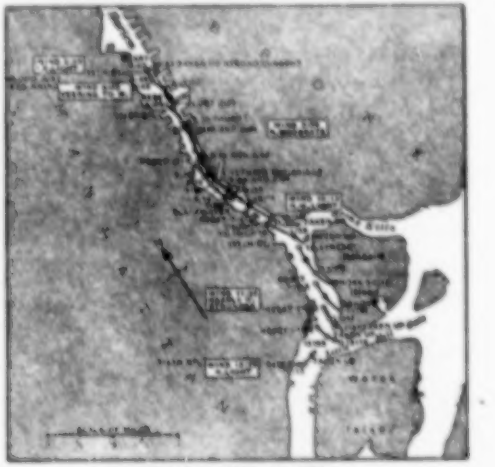


FLOAT 32, SEPT. 1, 1868
Total distance, flood, =0.77 miles in 4.91 hours
Average velocity ..... =0.16 miles per hour
Maximum " ..... =0.33 " " "

Paths of Floats in the East River and Upper Bay

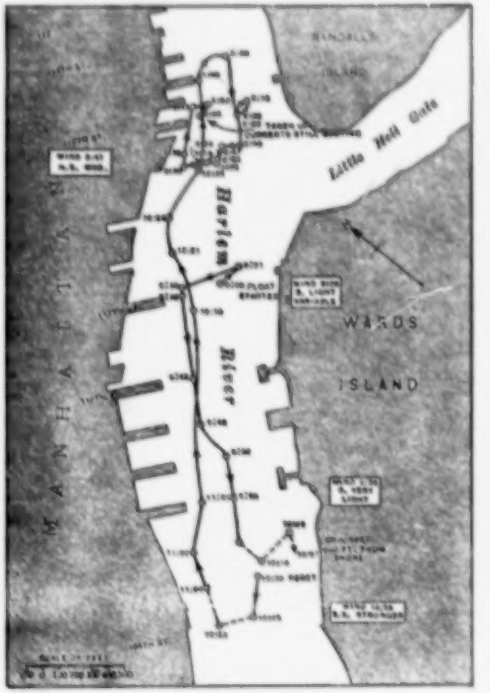


FLOAT 10, SEPT. 20, 1906



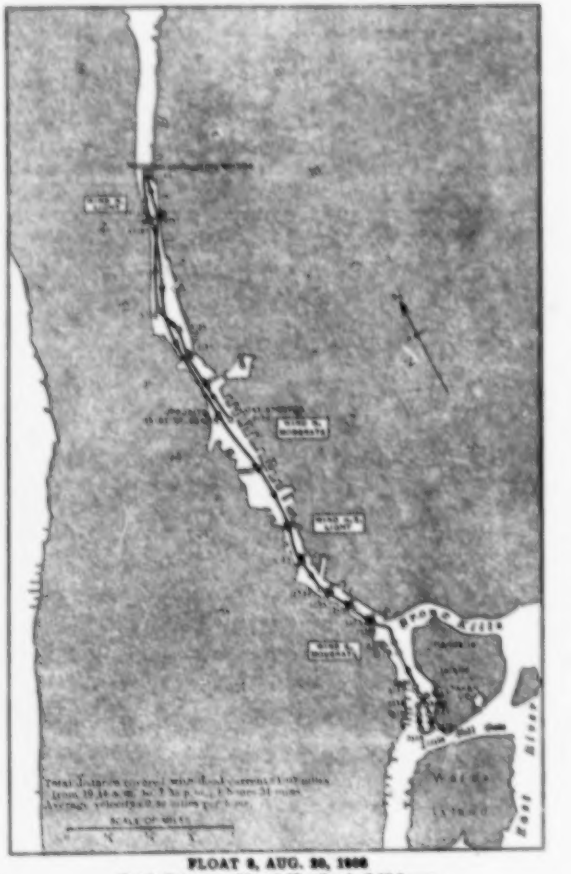
FLOAT 6, AUG. 18, 1906

Total distance, flood, =2.73 miles in 6.83 hours
Average velocity..... =0.40 miles per hour
Maximum " ..... =0.77 " " "
Total distance, ebb, =0.84 miles in 1.47 hours
Average velocity..... =0.57 miles per hour
Maximum " ..... =1.33 " " "



FLOAT 9, AUG. 21, 1906

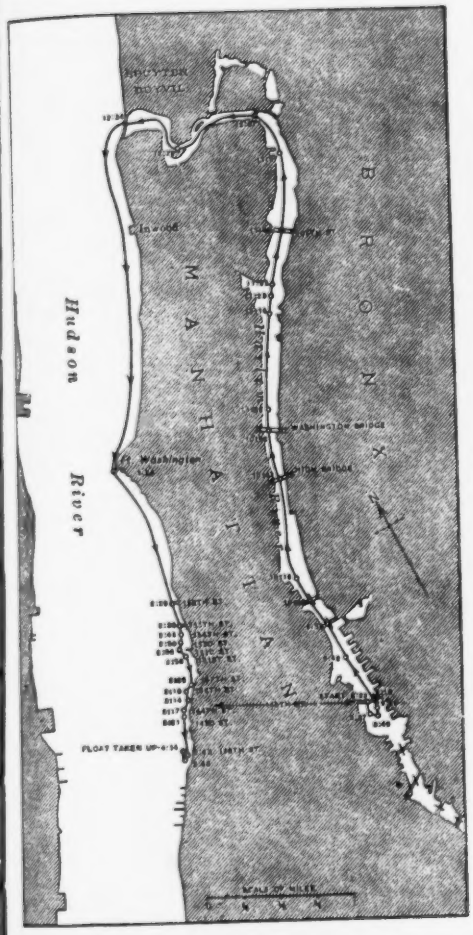
Total distance, flood, =0.74 miles in 2.12 hours
Average velocity..... =0.34 miles per hour
Maximum " ..... =1.24 " " "
Total distance, ebb, =0.74 miles in 2.08 hours
Average velocity..... =0.34 miles per hour
Maximum " ..... =0.87 " " "



FLOAT 8, AUG. 20, 1906

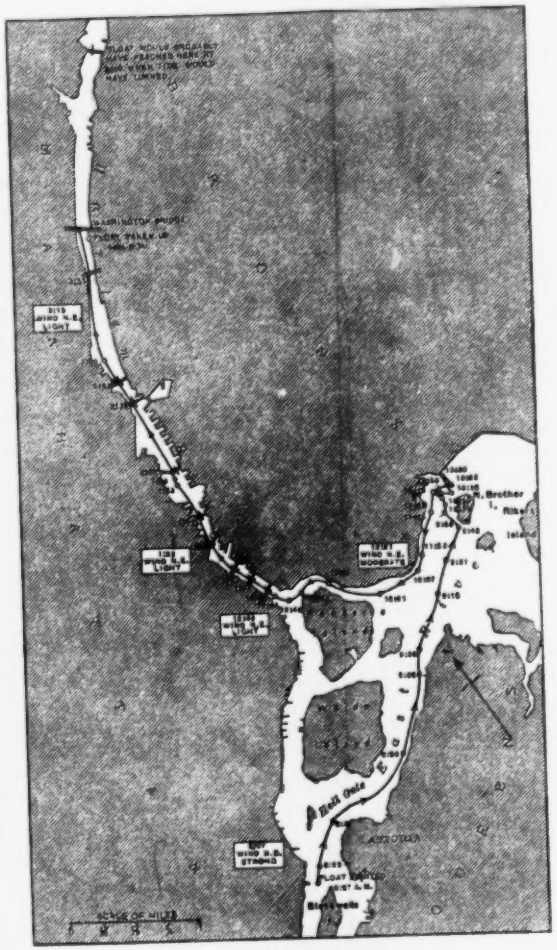
Total distance, ebb, =1.67 miles in 2.13 hours
Average velocity..... =0.78 miles per hour
Maximum " ..... =1.38 " " "
Flood, maximum velocity..... =2.00 " " "

Paths of Floats in the Harlem River



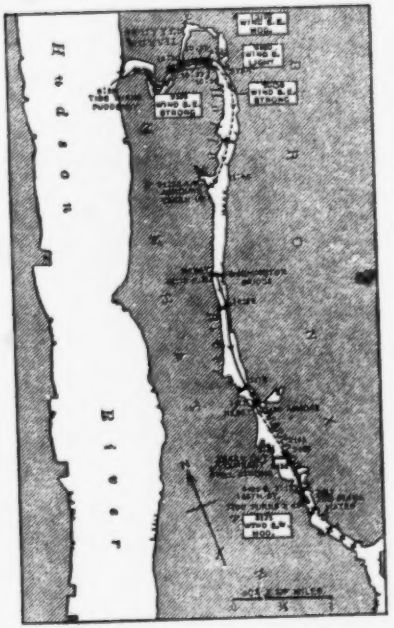
FLOAT 11, AUG. 25, 1906

Total distance, ebb, = 10.25 miles in 6.98 hours
Average velocity .... = 1.47 miles per hour
Maximum " .... = 2.79 " " "



FLOAT 14, AUG. 28, 1906

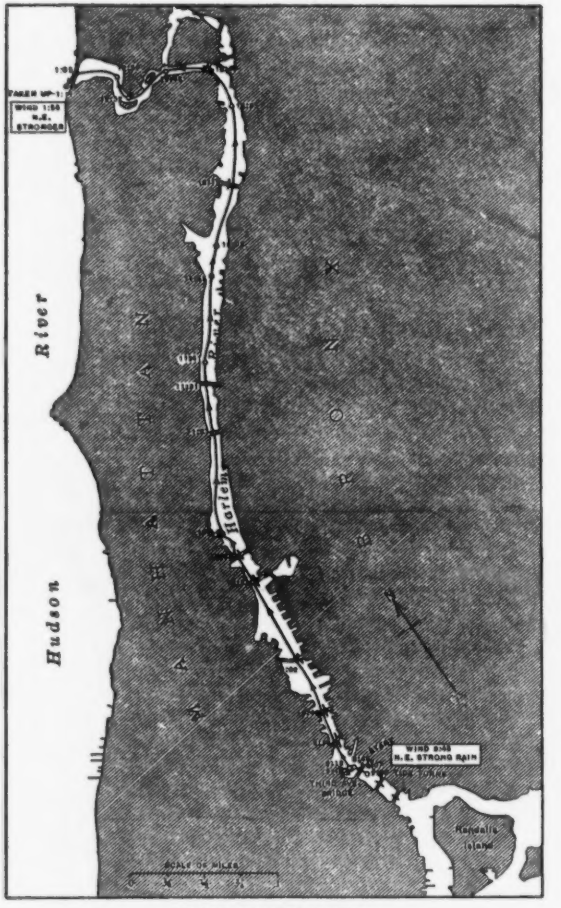
Total distance, flood, = 3.62 miles in 2.05 hours
Average velocity .... = 1.77 miles per hour
Maximum " .... = 4.20 " " "
Total distance, ebb, = 5.62 miles in 5.60 hours
Average velocity .... = 0.97 miles per hour
Maximum " .... = 1.49 " " "



FLOAT 7, AUG. 19, 1906

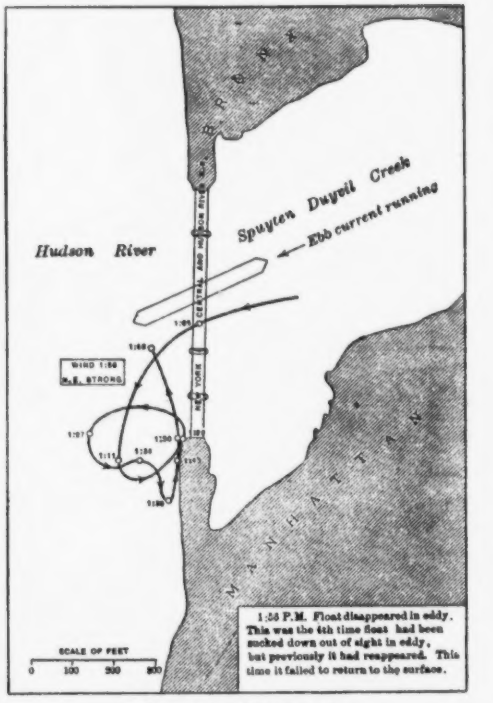
Total distance, flood, = 4.58 miles in 5.72 hours
Average velocity .... = 0.80 miles per hour
Maximum " .... = 1.22 " " "

Paths of Floats in the Harlem River

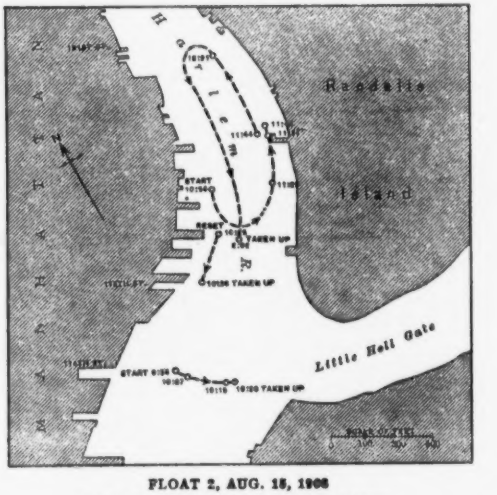


FLOAT 12, AUG. 26, 1908

Total distance, ebb, =6.45 miles in 4.18 hours
Average velocity.... =1.54 miles per hour
Maximum " .... =2.52 " " "



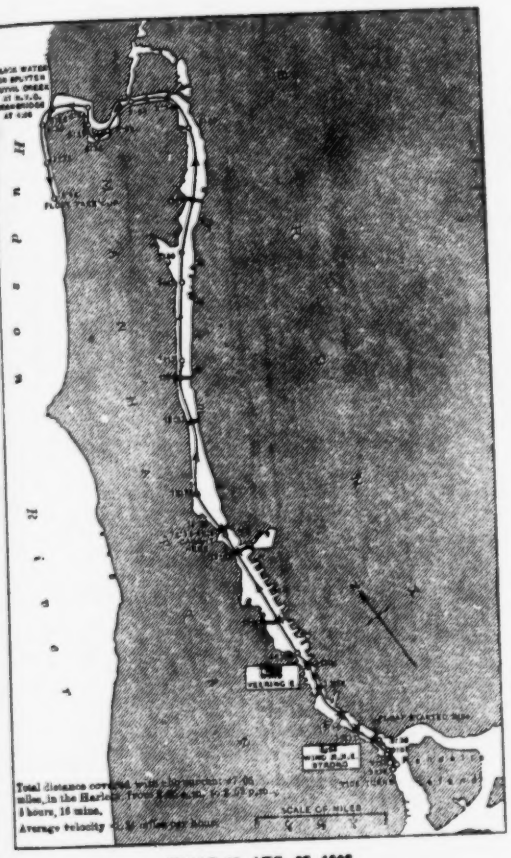
FLOAT 12A, AUG. 26, 1908



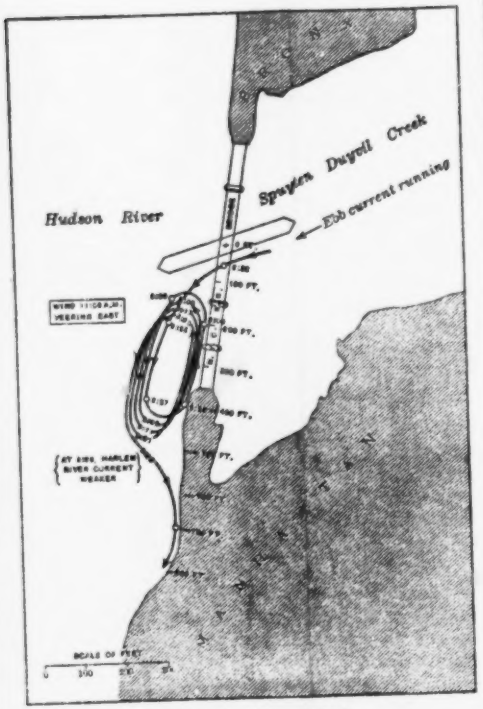
FLOAT 2, AUG. 15, 1908

Total distance, flood, =0.4 miles in 2.3 hours
Average velocity.... =0.17 miles per hour
Maximum " .... =0.32 " " "
Total distance, ebb, =0.31 miles in 1.46 hours
Average velocity.... =0.21 miles per hour
Maximum " .... =0.41 " " "

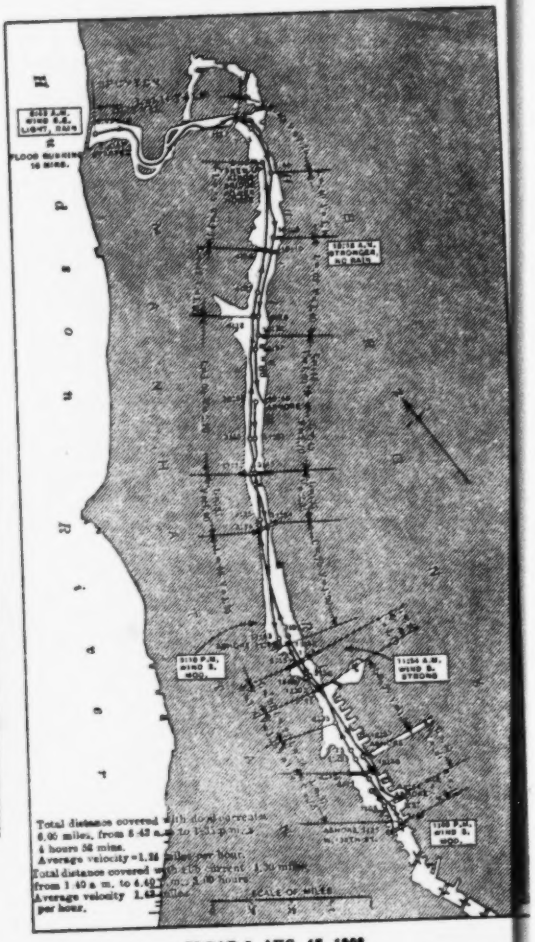
Paths of Floats in the Harlem River



FLOAT 12, AUG. 27, 1908
Maximum velocity = 2.64 miles per hour

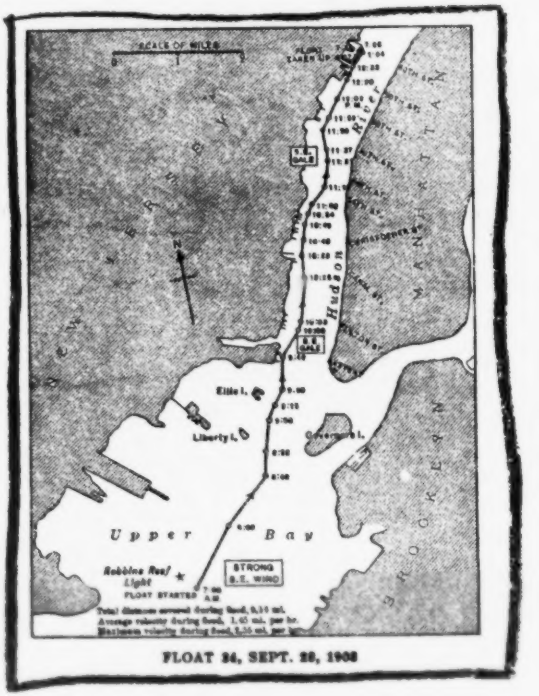


FLOAT 12A, AUG. 27, 1908

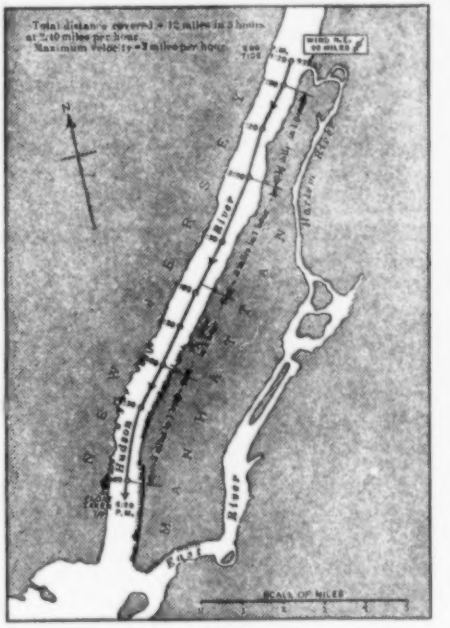


FLOAT 8, AUG. 17, 1908
Maximum velocity, flood, = 2.35 miles per hour
ebb, = 2.35

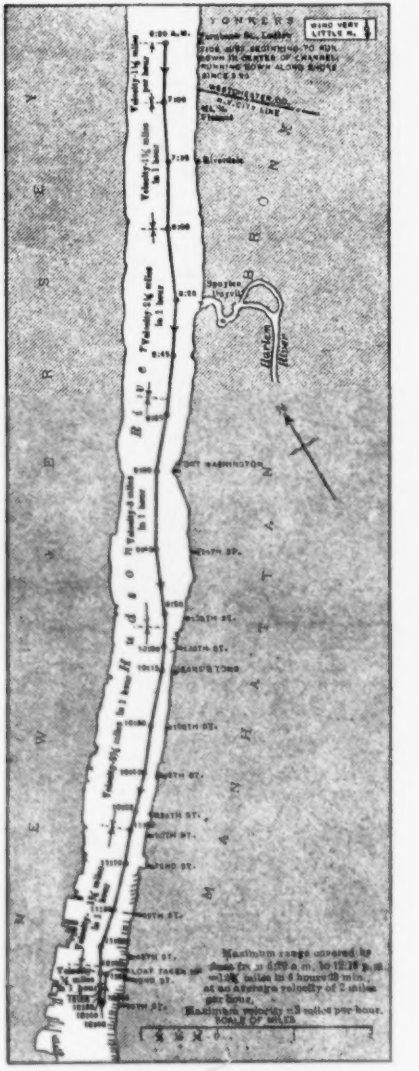
Paths of Floats in the Harlem River



FLOAT 24, SEPT. 28, 1908

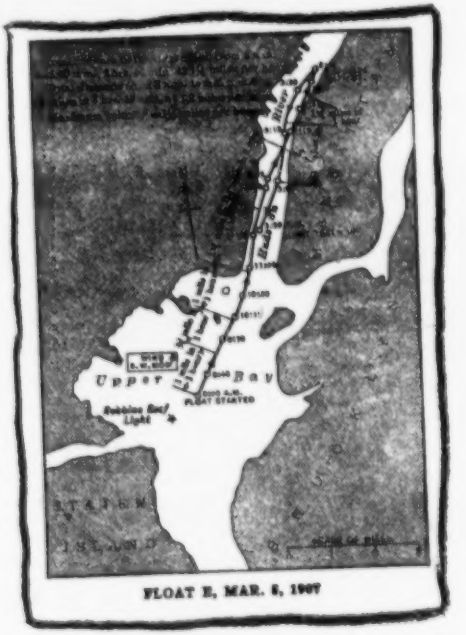


FLOAT M, APRIL 2, 1907

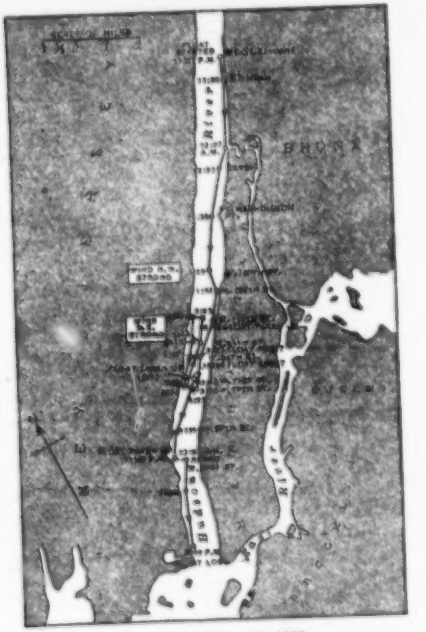


FLOAT Y, JULY 19, 1907

Paths of Floats in the Hudson River

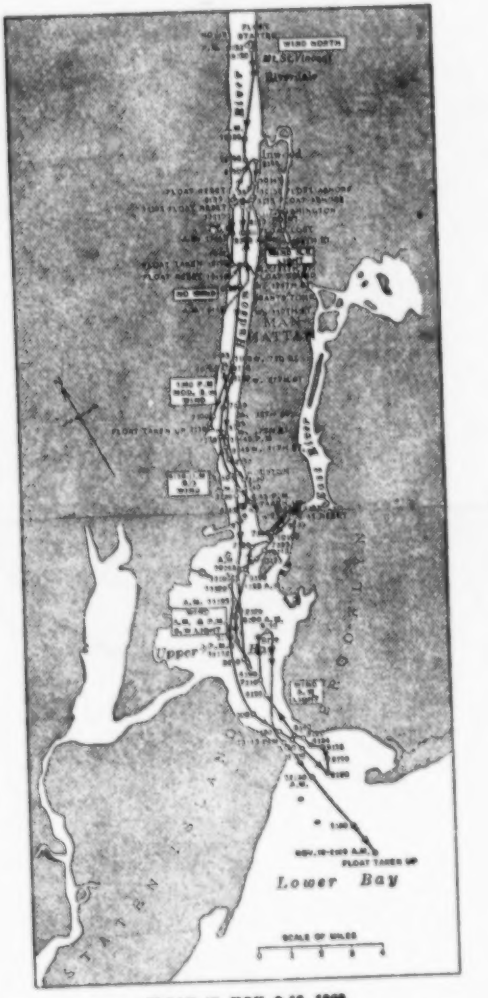


FLOAT E, MAR. 6, 1907



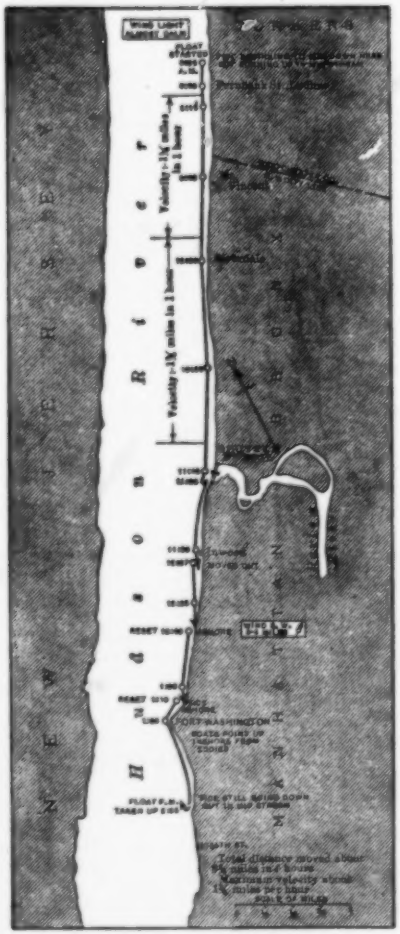
FLOAT 46, NOV. 8-9, 1909

Total distance, ebb, = 16.76 miles in 9.83 hours
Average velocity... = 1.71 miles per hour
Maximum " ... = 4.2 " " "

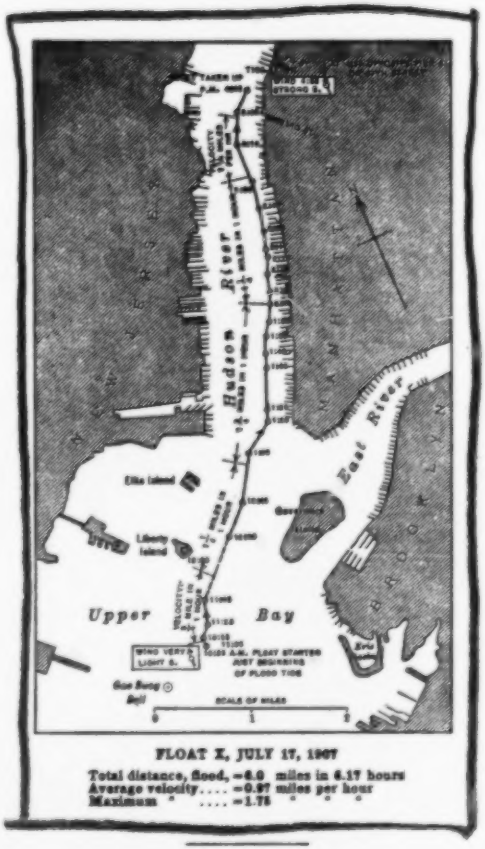


FLOAT 47, NOV. 9-12, 1909

Total distance, flood, = 20.45 miles in 20.05 hours
Average velocity.... = 1.02 miles per hour
Maximum " ... = 1.76 " " "
Total distance, ebb, = 47.2 miles in 27.22 hours
Average velocity.... = 1.72 miles per hour
Maximum " ... = 3.2 " " "



FLOAT Z, JULY 22, 1907
Average velocity, ebb, =1.13 miles per hour

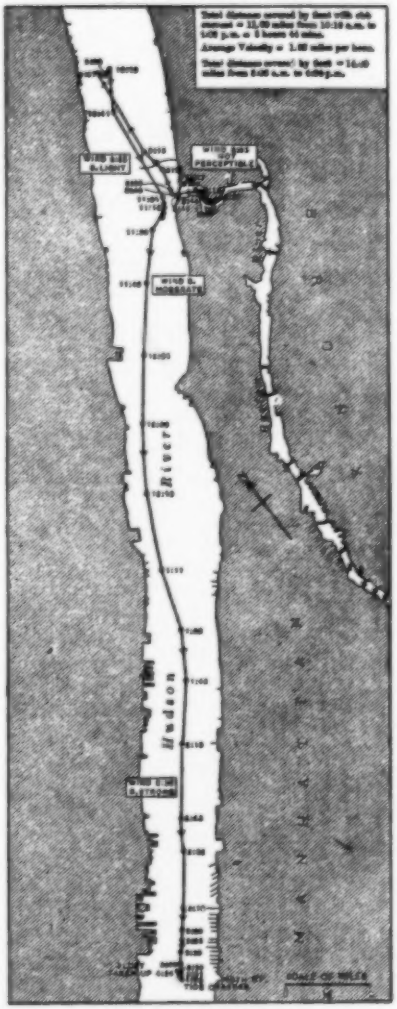


FLOAT X, JULY 17, 1907

Total distance, flood, =6.0 miles in 4.17 hours
Average velocity.... =0.97 miles per hour
Maximum " .... =1.75 " " "

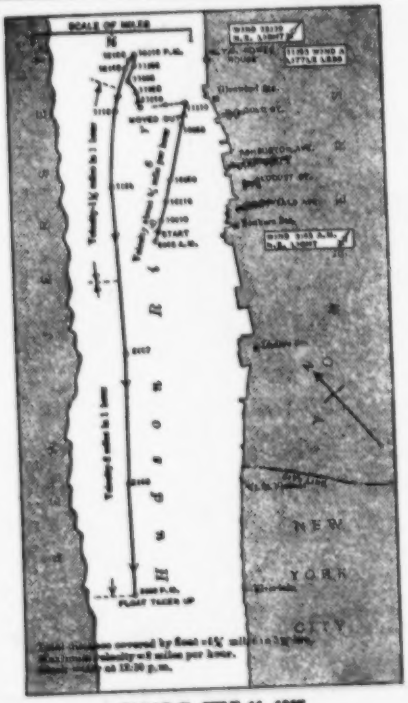
FLOAT 24

Total distance, flood, =3.0 miles in 1.81 hours
Average velocity.... =1.66 miles per hour
Maximum " .... =4.6 " " "
Ebb, maximum velocity..... =2.24 " " "

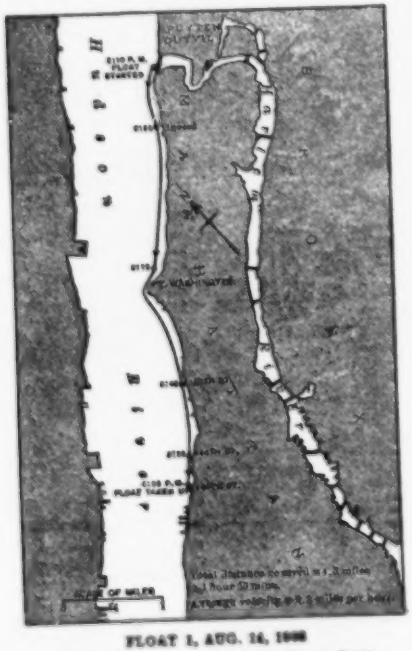


FLOAT 24, SEPT. 9, 1908

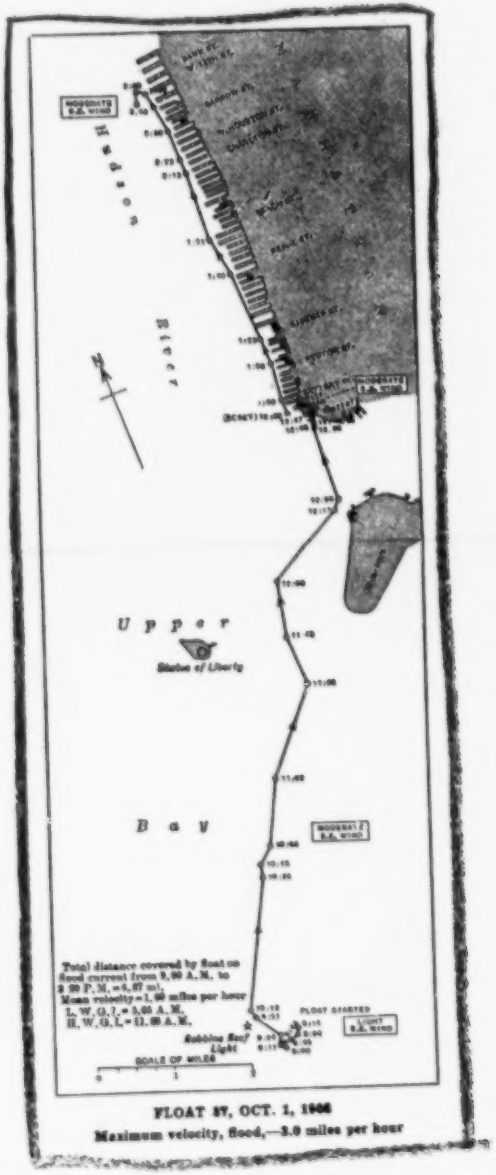
Paths of Floats in the Hudson River



FLOAT V, JULY 11, 1907
Average velocity, ebb, −0.9 miles per hour



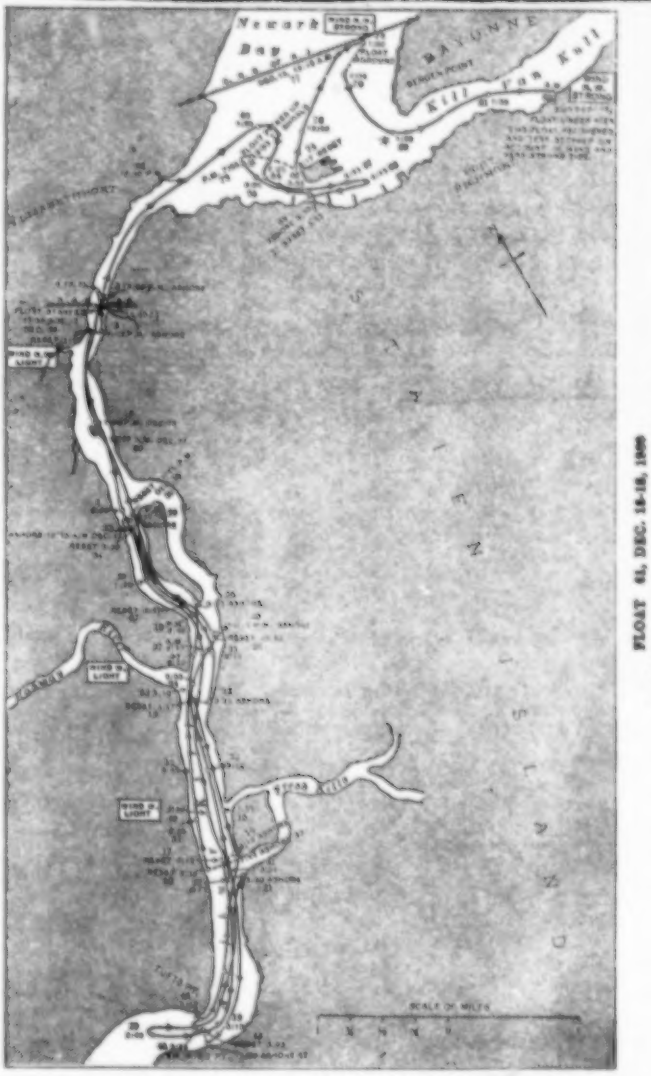
FLOAT 1, AUG. 16, 1906
Maximum velocity, ebb, −2.07 miles per hour



FLOAT 37, OCT. 1, 1906
Maximum velocity, flood,—3.0 miles per hour

Paths of Floats in the Hudson River and Upper Bay

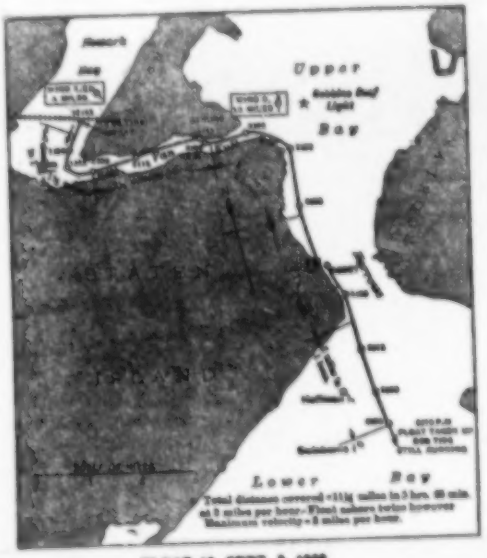
FLOAT 58, SEPT. 16, 1908



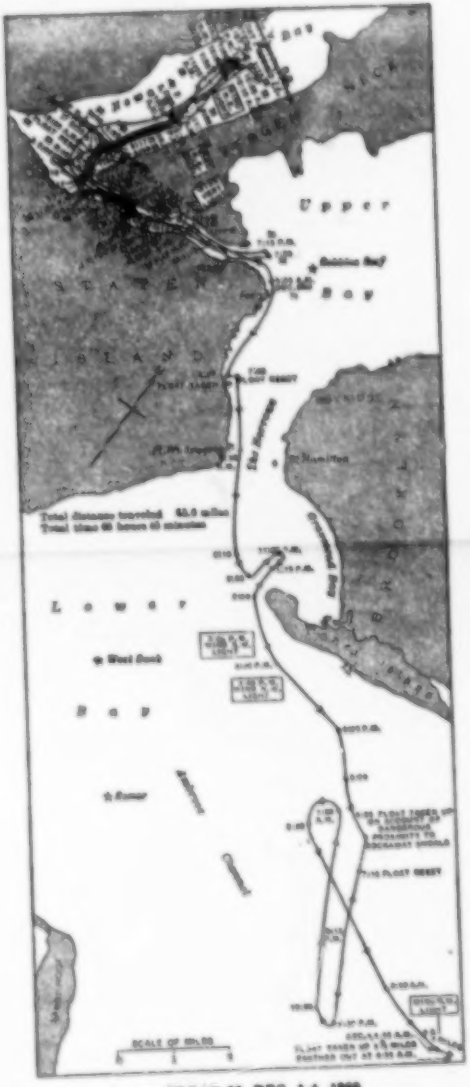
FLOAT 61, DEC. 16-18, 1908

Total distance, flood, = 16.97 miles in 21.5 hours
Average velocity .... = 0.78 miles per hour
Maximum " .... = 1.80 " " "
Total distance, ebb, = 11.8 miles in 15.0 hours
Average velocity .... = 0.79 miles per hour
Maximum " .... = 2.38 " " "

Paths of Floats in the Kill Van Kull and Arthur Kill

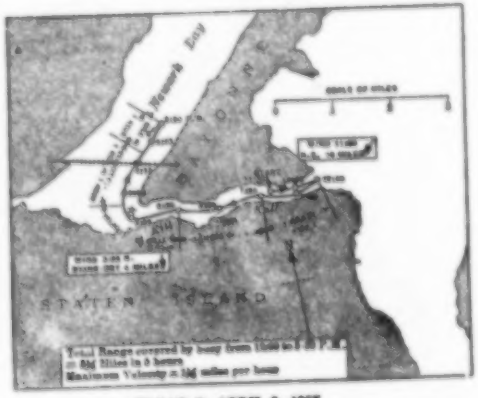


FLOAT 10, SEPT. 8, 1906



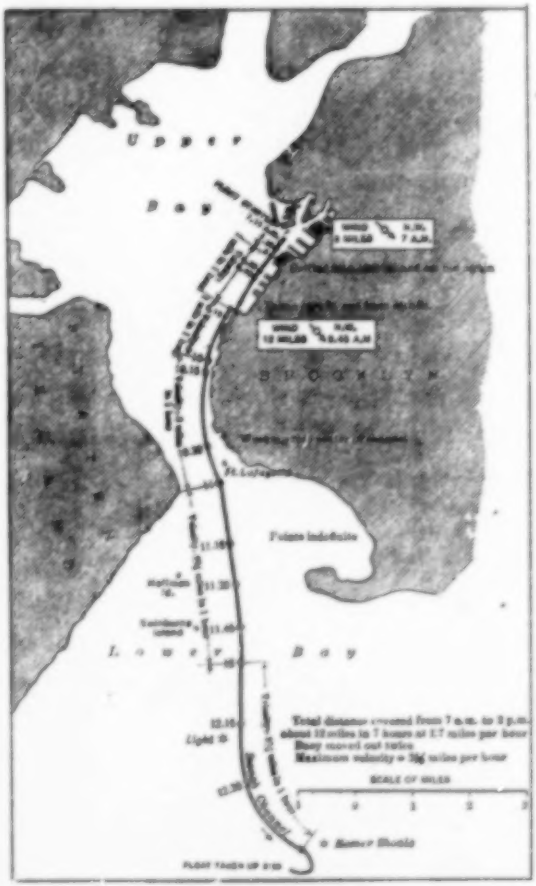
FLOAT 98, DEC. 1-4, 1906

Total distance, flood, = 20.92 miles in 22.12 hours
Average velocity .... = 0.82 miles per hour
Maximum " .... = 1.30 " "
Total distance, ebb, = 44.9 miles in 50.8 hours
Average velocity .... = 1.16 miles per hour
Maximum " .... = 4.00 " "

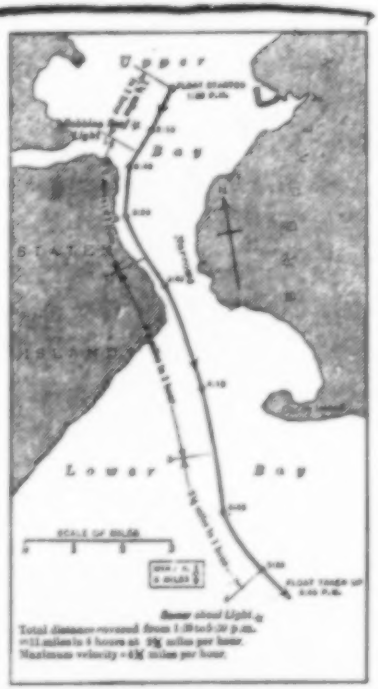


FLOAT O, APRIL 8, 1907
Average velocity, flood, = 1.08 miles per hour

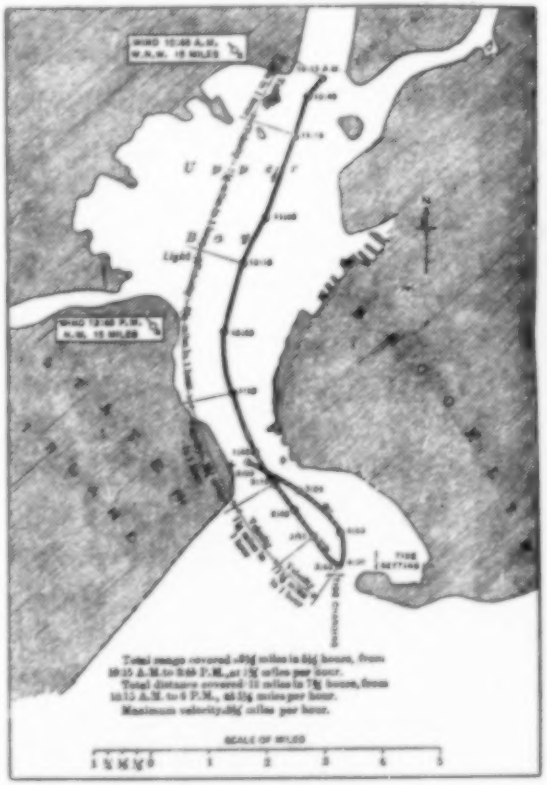
Paths of Floats in Newark Bay and Kill Van Kull



FLOAT A, FEB. 28, 1907

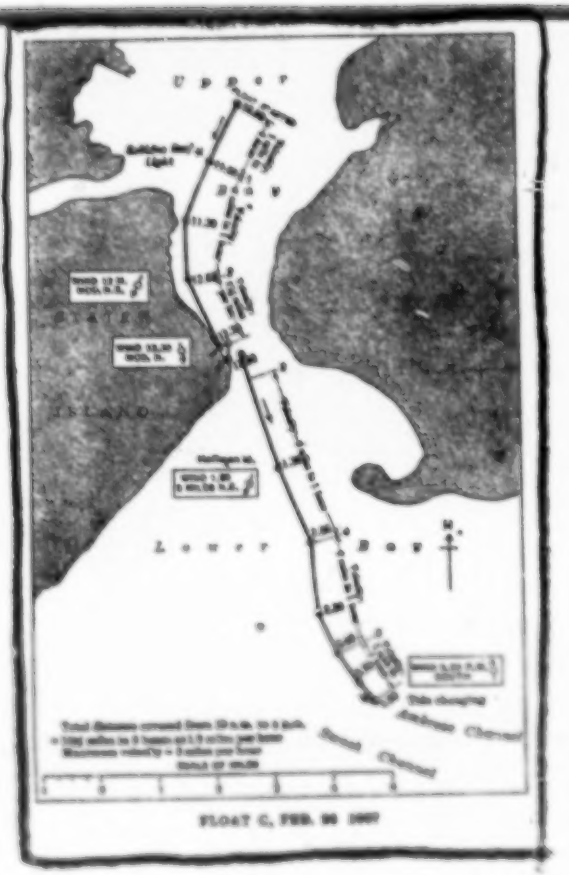


FLOAT D, MAR. 4, 1907

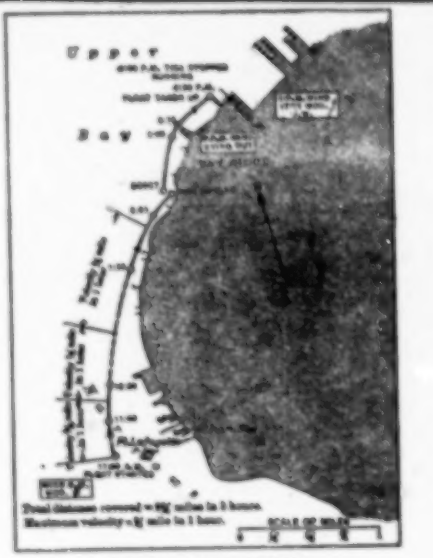


FLOAT B, FEB. 28, 1907

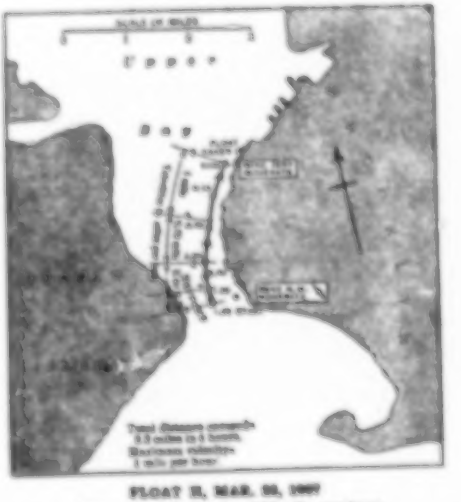
Paths of Floats in the Upper Bay



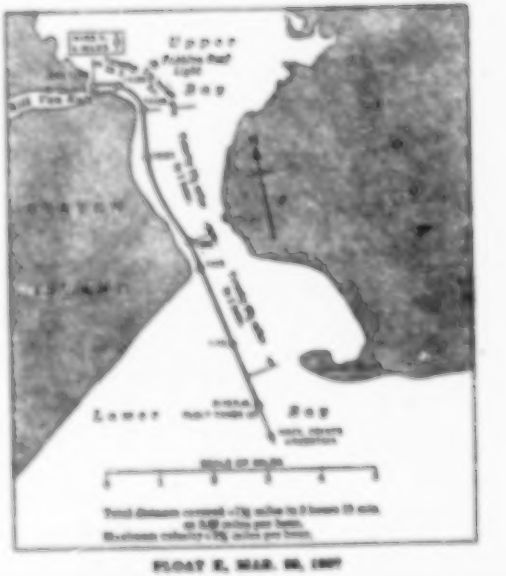
FLOAT C, FEB. 26 1907



FLOAT G, MAR. 22, 1907
Average velocity, flood, =0.66 miles per hour



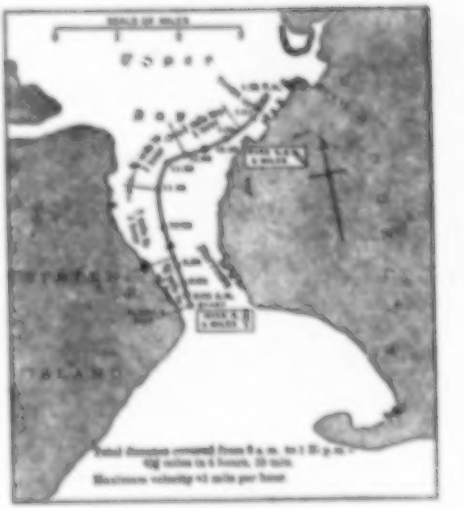
FLOAT H, MAR. 22, 1907
Average velocity, flood, =0.66 miles per hour



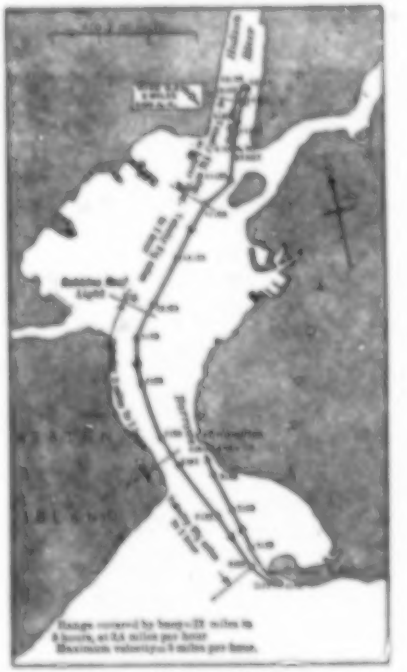
FLOAT E, MAR. 26, 1907

Paths of Floats in the Upper Bay

FLOAT J, MAR. 27, 1907



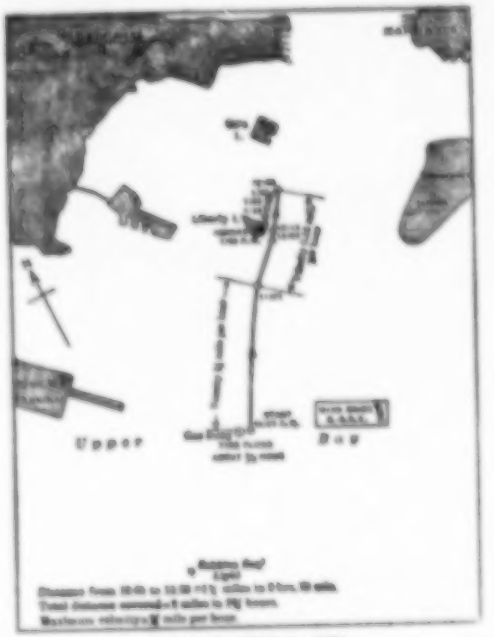
FLOAT O, APRIL 4, 1907
Average velocity, flood, =0.98 miles per hour



FLOAT R, APRIL 18, 1907

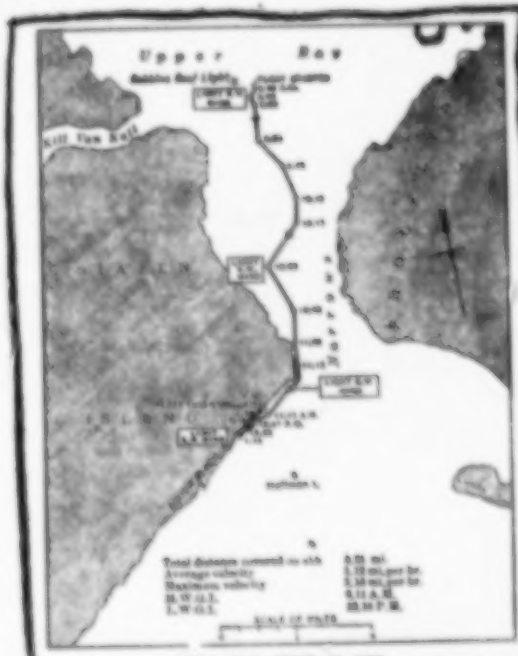
FLOAT T, JULY 8, 1907
Total distance, flood, =5.5 miles in 5.83 hours
Average velocity ..... =0.77 miles per hour
Maximum " ..... =1.05

Paths of Floats in the Upper Bay



FLOAT W, JULY 14, 1907

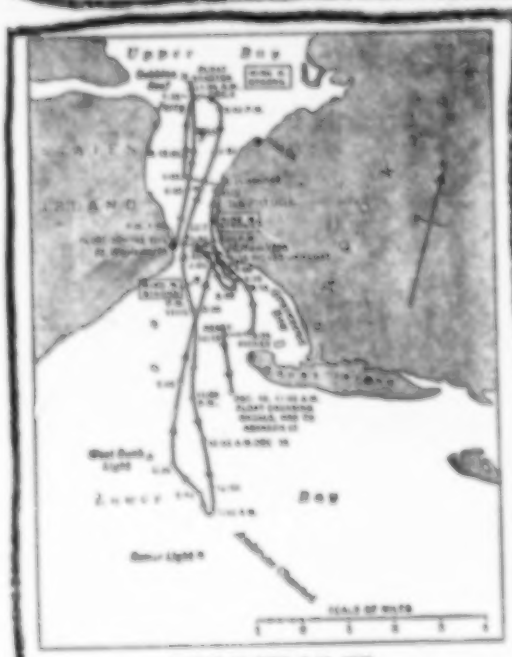
Average velocity, flood, =0.[illegible] miles per hour



FLOAT [illegible], SEPT. [illegible], [illegible]

FLOAT [illegible], SEPT. 11, [illegible]

Average velocity, flood, =1.[illegible] miles per hour
Maximum " " =1.[illegible] " " "



FLOAT [illegible], DEC. [illegible], [illegible]

Total distance, flood, =[illegible] miles in [illegible] hours
Average velocity.... = 1.[illegible] miles per hour
Maximum " .... = [illegible] " " "
Total distance, ebb, =17.[illegible] miles in [illegible] hours
Average velocity.... = 1.[illegible] miles per hour
Maximum " .... = [illegible] " " "

Paths of Floats in the Upper Bay

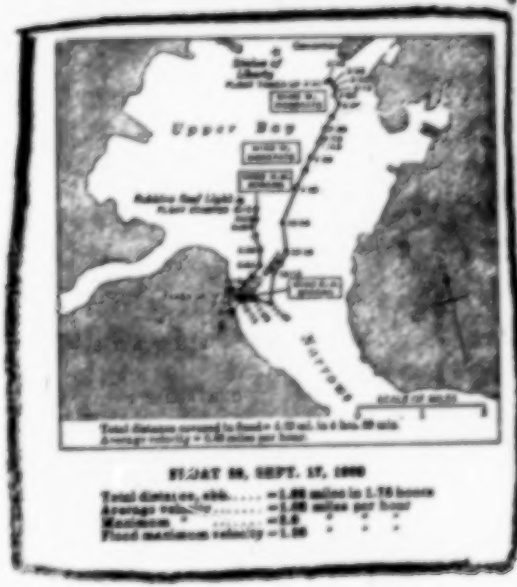
FLOAT 67, DEC. 6-8, 1909

Total distance, flood, = 16.8 miles in 14.75 hours
Average velocity .... = 1.07 miles per hour
Maximum " .... = 4.44 " " "
Total distance, ebb, = 24.45 miles in 20.5 hours
Average velocity .... = 1.13 miles per hour
Maximum " .... = 3.81 " " "

FLOAT 68, NOV. 16-17, 1909

Total distance, flood, = 16.7 miles in 12.25 hours
Average velocity .... = 1.19 miles per hour
Maximum " .... = 4.88 " " "
Total distance, ebb, = 17.1 miles in 12.5 hours
Average velocity .... = 1.29 miles per hour
Maximum " .... = 4.88 " " "

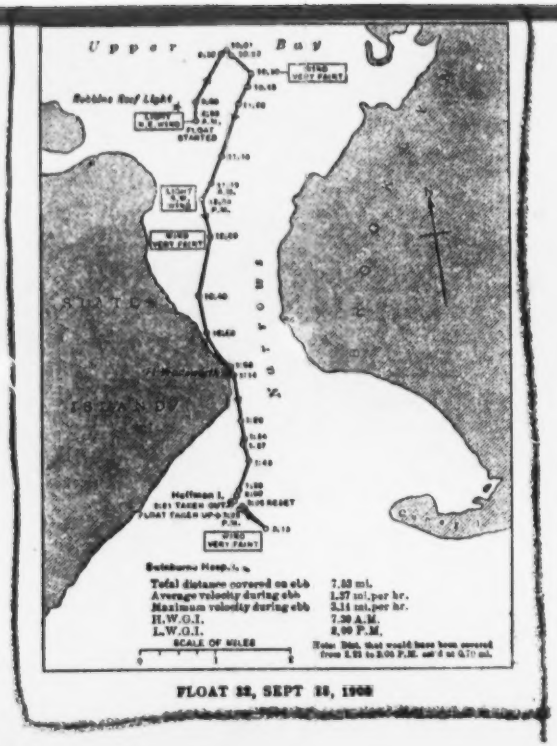
FLOAT 66, SEPT. 15, 1909



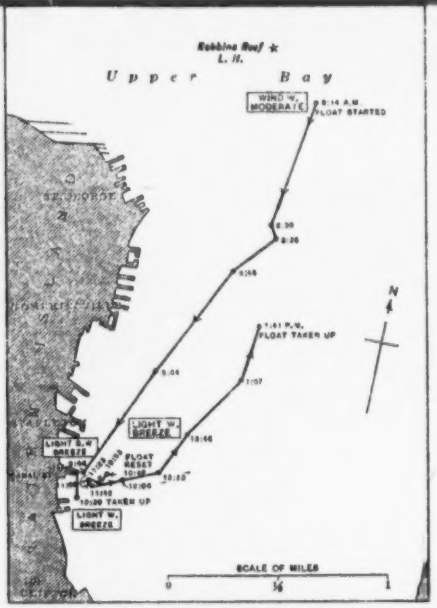
FLOAT 69, SEPT. 17, 1909

Total distance, ebb, ... = 1.88 miles in 1.75 hours
Average velocity .... = 1.08 miles per hour
Maximum " .... = 2.5 " " "
Flood maximum velocity = 1.56 " " "

Paths of Floats in the Upper Bay



FLOAT 22, SEPT 25, 1906

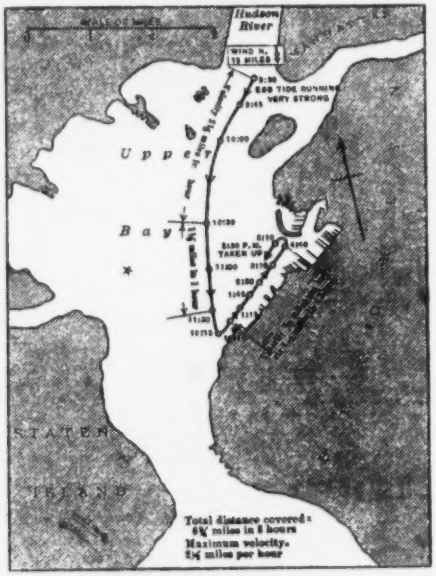


FLOAT 20, SEPT. 18, 1906

Total distance, flood, =1.3 miles in 2.68 hours
Average velocity.... =0.46 miles per hour
Maximum " .... =1.02 " " "
Total distance, ebb, =2.23 miles in 3.06 hours
Average velocity.... =0.78 miles per hour
Maximum " .... =2.38 " " "

FLOAT 24, SEPT. 26, 1906

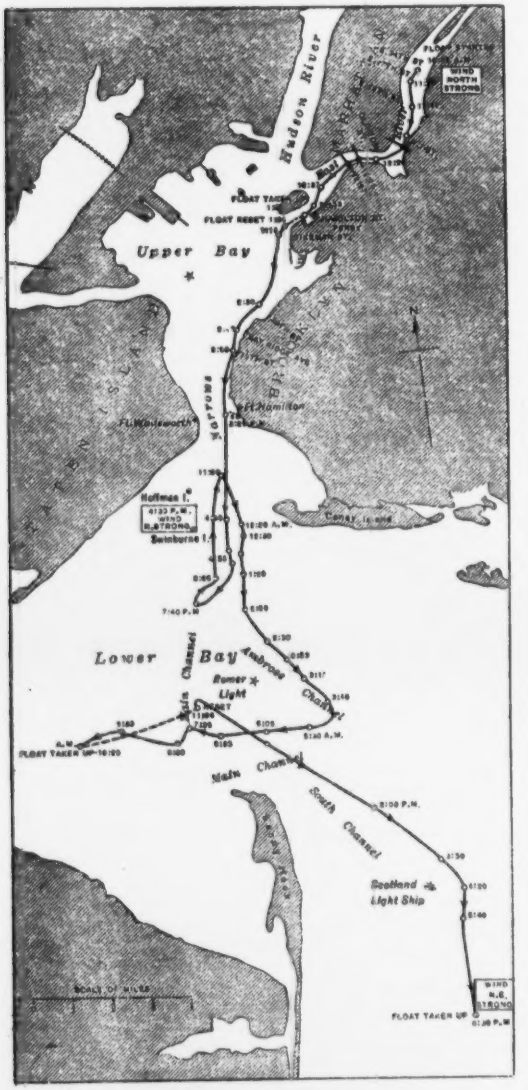
Total distance, flood, =2.22 miles in 3.75 hours
Average velocity.... =0.59 miles per hour
Maximum " .... =2.52 " " "



FLOAT P, APRIL 6, 1907

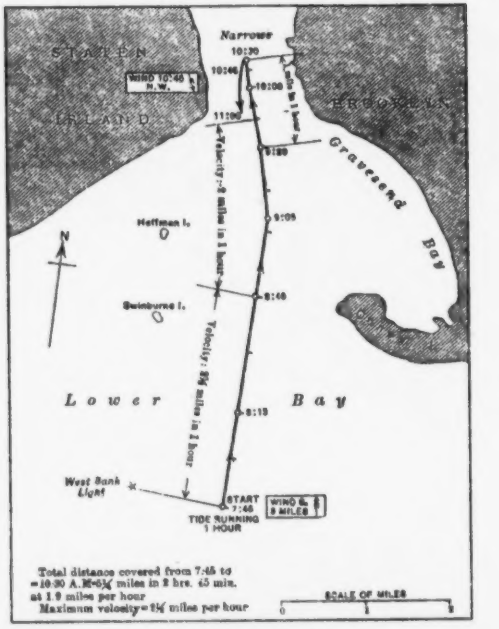
Total distance, flood, =1.09 miles in 4.5 hours
Average velocity.... =0.24 miles per hour
Maximum " .... =0.36 " " "
Total distance, ebb, =4.32 miles in 3.75 hours
Average velocity.... =1.15 miles per hour
Maximum " .... =2.5 " " "

Paths of Floats in the Upper Bay

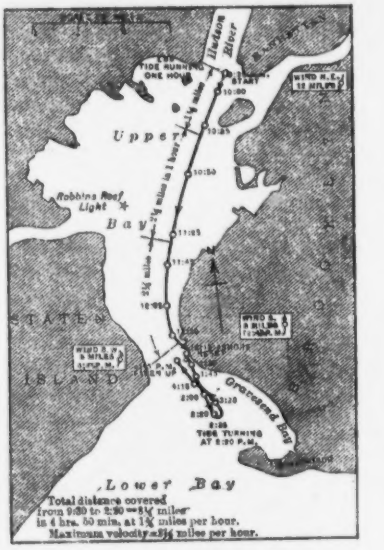


FLOAT 55, NOV. 29-30, 1909

Total distance, flood, = 10.71 miles in 10.37 hours
Average velocity .... = 1.04 miles per hour
Maximum " .... = 2.4 " "
Total distance, ebb, = 33.46 miles in 20.16 hours
Average velocity .... = 1.66 miles per hour
Maximum " .... = 5.7 " "



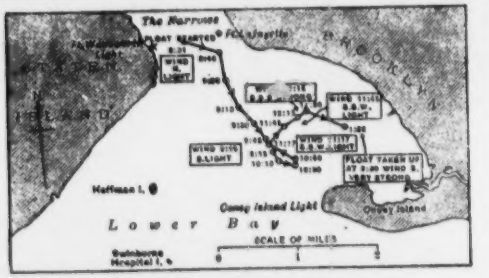
FLOAT S, APRIL 13, 1907



FLOAT I, MAR. 25, 1907

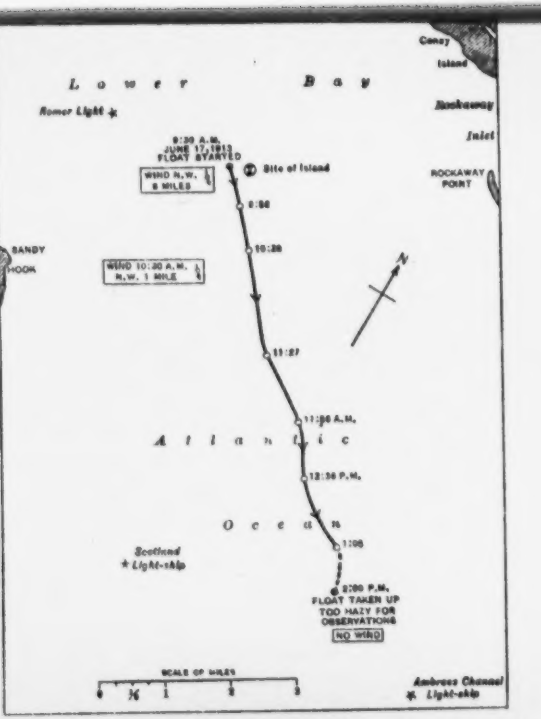
Total distance, flood, = 1.75 miles in 3.42 hours
Average velocity .... = 0.72 miles per hour
Maximum " .... = 1.26 " " "

Paths of Floats in the Upper and Lower Bays



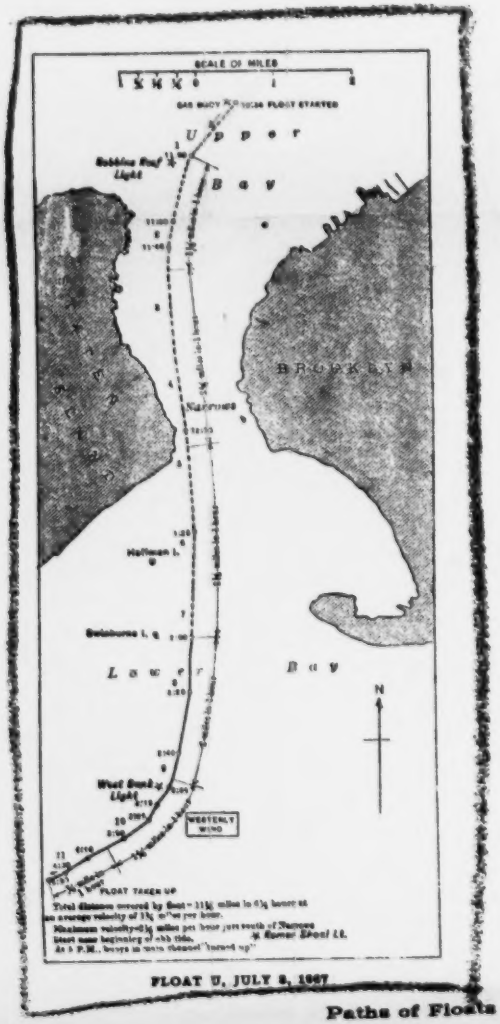
FLOAT 21, SEPT. 4, 1908

Total distance, ebb, =2.27 miles in 1.96 hours
Average velocity .... =1.3 miles per hour
Maximum " .... =1.76 " "

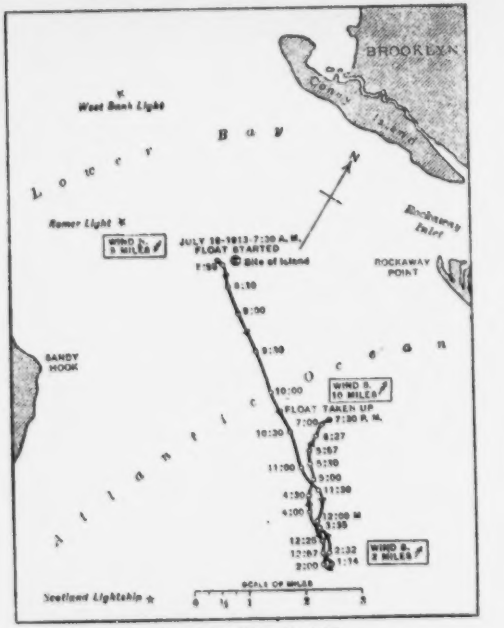


FLOAT 70, JUNE 17, 1913

Total distance, ebb, =4.13 miles in 5.0 hours
Average velocity .... =0.83 miles per hour
Maximum " .... =1.17 " "



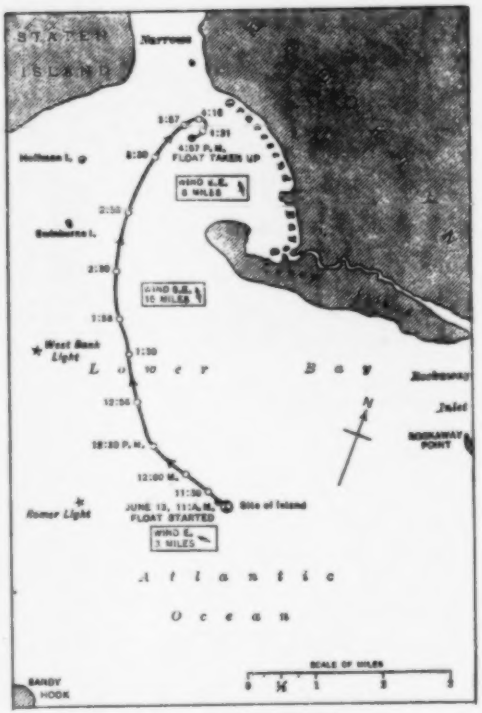
FLOAT U, JULY 8, 1907



FLOAT 83, JULY 16, 1913

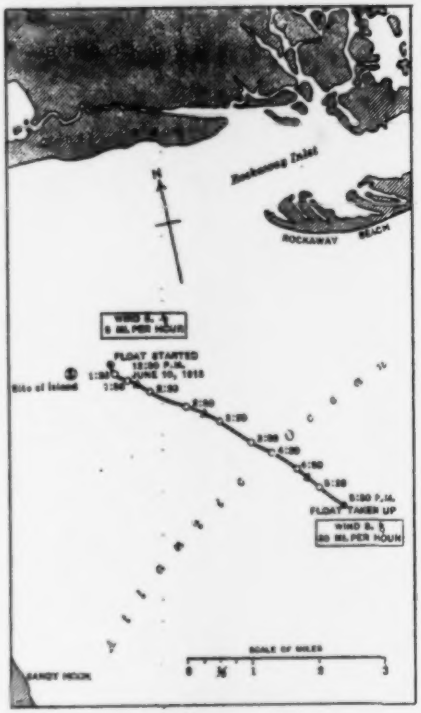
Total distance, flood, =2.84 miles in 5.83 hours
Average velocity .... =0.48 miles per hour
Maximum " .... =0.63 " "
Total distance, ebb, =6.0 miles in 6.07 hours
Average velocity .... =0.99 miles per hour
Maximum " .... =1.62 " "

Paths of Floats in the Lower Bay



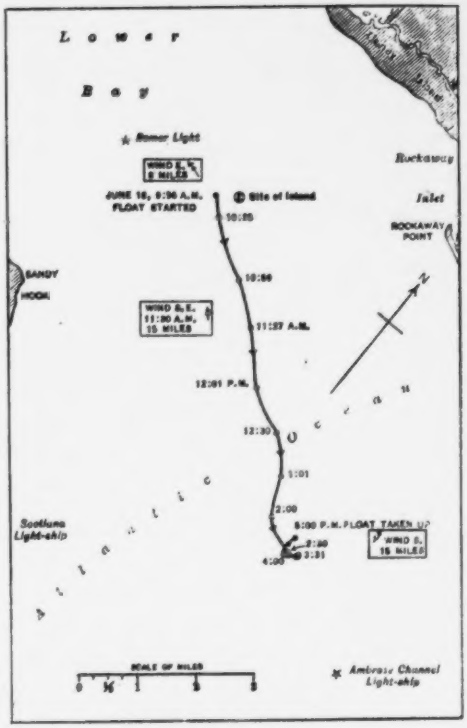
FLOAT 66, JUNE 13, 1913

Total distance, flood, = 6.63 miles in 5.27 hours
Average velocity . . . . = 1.26 miles per hour
Maximum " . . . . = 1.85 " " "



FLOAT 68, JUNE 10, 1913

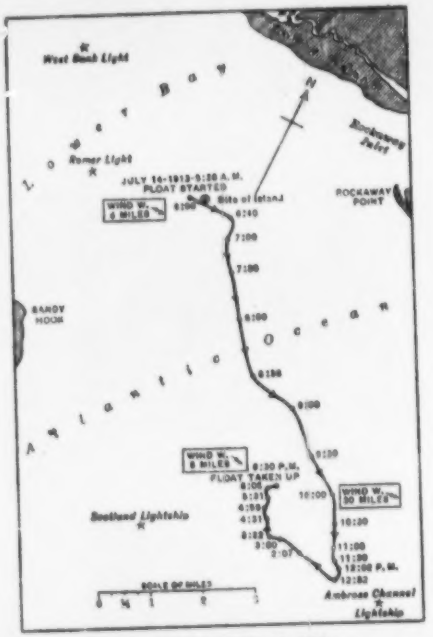
Total distance, ebb, = 4.12 miles in 5.0 hours
Average velocity . . . = 0.82 miles per hour
Maximum " . . . = 1.17 " " "



FLOAT 71, JUNE 18, 1913

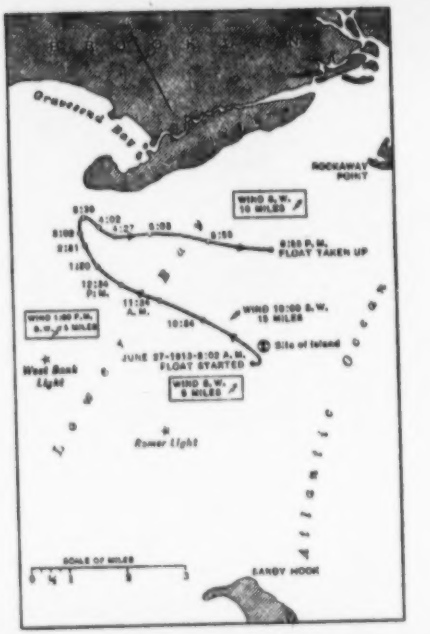
Total distance, ebb, = 6.44 miles in 5.6 hours
Average velocity . . . = 1.15 miles per hour
Maximum " . . . = 2.14 " " "

Paths of Floats in the Lower Bay



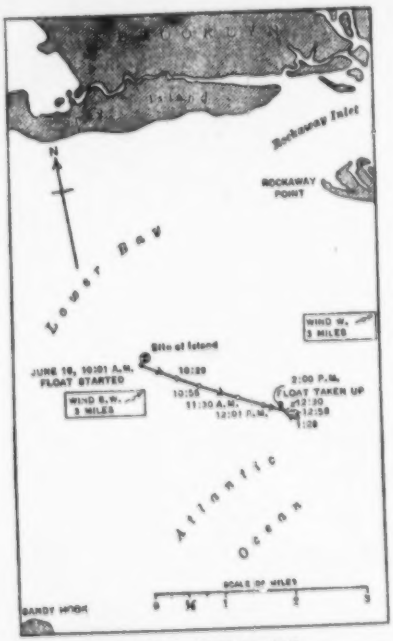
FLOAT 81, JULY 16, 1913

Total distance, flood, —2.78 miles in 6.25 hours
Average velocity.... —0.41 miles per hour
Maximum " .... —0.71 " " "
Total distance, ebb, —8.24 miles in 6.68 hours
Average velocity.... —1.26 miles per hour
Maximum " .... —2.08 " " "



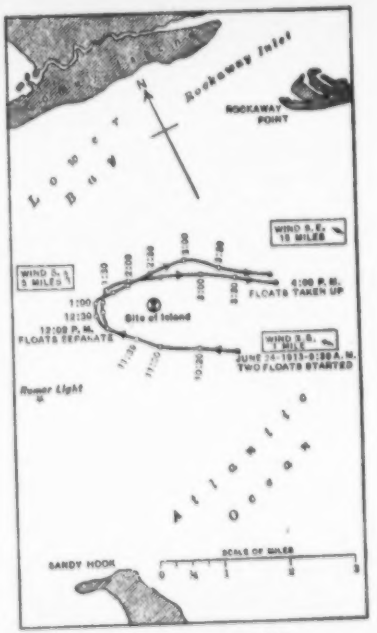
FLOAT 77, JUNE 27, 1913

Total distance, flood, —4.42 miles in 7.47 hours
Average velocity.... —0.59 miles per hour
Maximum " .... —0.83 " " "
Total distance, ebb, —3.63 miles in 3.49 hours
Average velocity.... —1.0 miles per hour
Maximum " .... —1.16 " " "



FLOAT 68, JUNE 16, 1913

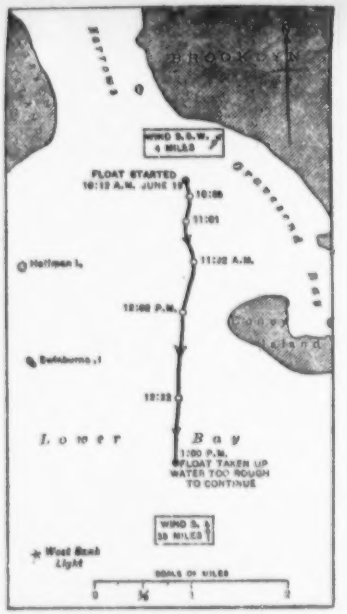
Total distance, ebb, —2.27 miles in 2.45 hours
Average velocity.... —0.69 miles per hour
Maximum " .... —1.86 " " "



FLOAT 75, JUNE 24, 1913

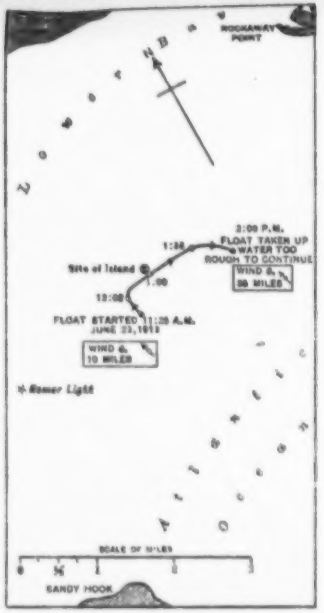
Total distance, flood, —2.84 miles in 3.26 hours
Average velocity.... —0.85 miles per hour
Maximum " .... —0.93 " " "
Total distance, ebb, —2.84 miles in 3.0 hours
Average velocity.... —0.86 miles per hour
Maximum " .... —1.44 " " "

Paths of Floats in the Lower Bay



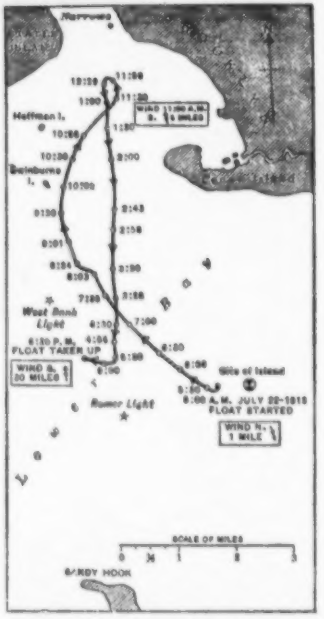
FLOAT 72, JUNE 19, 1913

Total distance, ebb, =2.84 miles in 7.8 hours
Average velocity.... =1.02 miles per hour
Maximum " .... =1.51 " " "



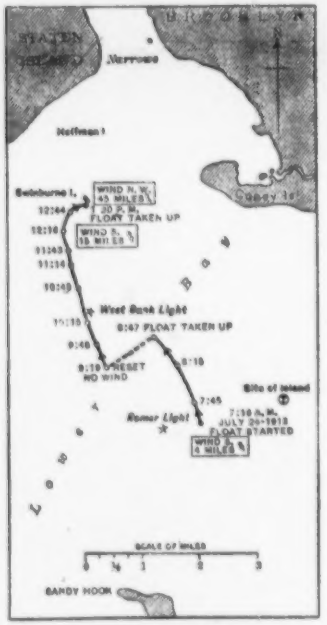
FLOAT 74, JUNE 23, 1913

Total distance, flood, =0.92 miles in 0.42 hours
Average velocity.... =0.51 miles per hour
Maximum " .... =0.62 " " "
Total distance, ebb, =1.70 miles in 1.97 hours
Average velocity.... =0.86 miles per hour
Maximum " .... =1.28 " " "



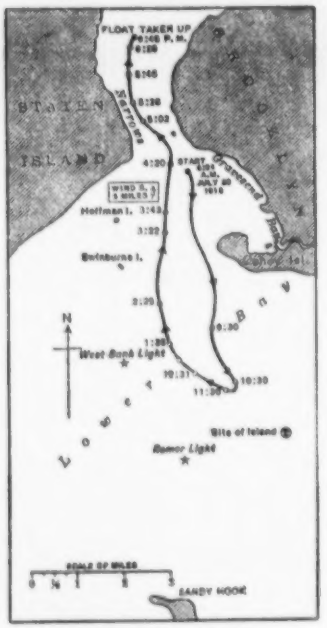
FLOAT 82, JULY 22, 1913

Total distance, flood, =6.60 miles in 6.98 hours
Average velocity.... =0.95 miles per hour
Maximum " .... =1.47 " " "
Total distance, ebb, =4.74 miles in 3.68 hours
Average velocity.... =0.86 miles per hour
Maximum " .... =1.19 " " "



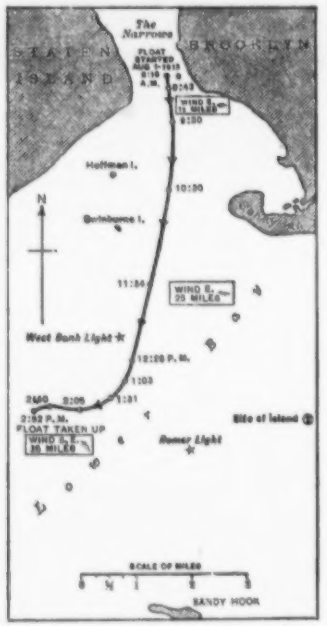
FLOAT 84, JULY 24, 1913

Total distance, flood, =4.74 miles in 5.70 hours
Average velocity.... =0.83 miles per hour
Maximum " .... =1.02 " " "



FLOAT 87, JULY 30, 1913

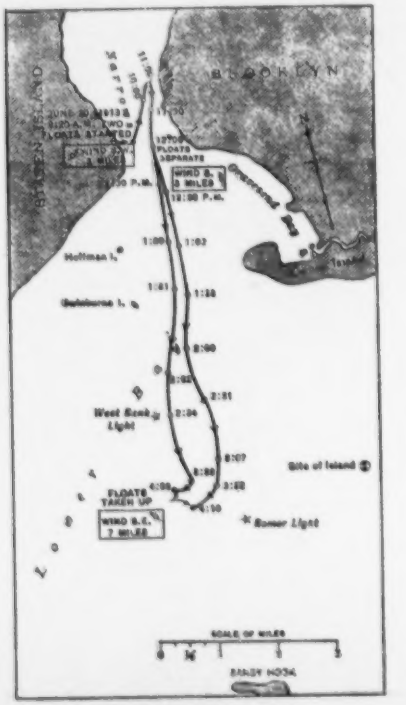
Total distance, flood, =6.52 miles in 6.36 hours
Average velocity.... =1.03 miles per hour
Maximum " .... =1.68 " " "
Total distance, ebb, =4.61 miles in 4.1 hours
Average velocity.... =1.13 miles per hour
Maximum " .... =1.30 " " "



FLOAT 88, AUG. 1, 1913

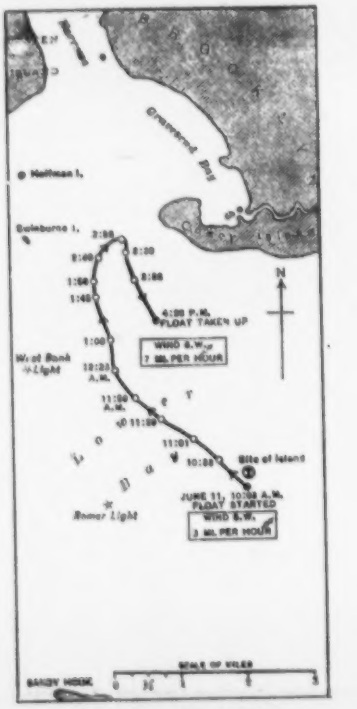
Total distance, flood, =1.32 miles in 1.16 hours
Average velocity.... =0.99 miles per hour
Maximum " .... =0.99 " " "
Total distance, ebb, =6.98 miles in 5.35 hours
Average velocity.... =1.13 miles per hour
Maximum " .... =1.89 " " "

Paths of Floats in the Lower Bay



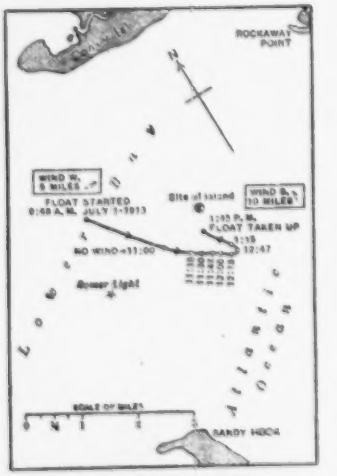
FLOAT 72, JUNE 26, 1913

Total distance, ebb, =7.46 miles in 5.17 hours
Average velocity .... =1.44 miles per hour
Maximum " .... =2.05 " " "



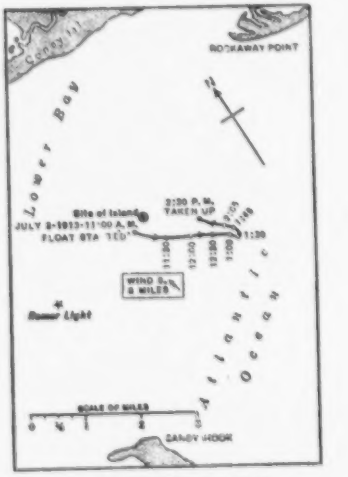
FLOAT 67, JUNE 11, 1913

Total distance, flood, =4.84 miles in 4.02 hours
Average velocity .... =0.98 miles per hour
Maximum " .... =1.14 " " "
Total distance, ebb, =1.33 miles in 1.8 hours
Average velocity .... =0.89 miles per hour
Maximum " .... =1.24 " " "



FLOAT 78, JULY 1, 1913

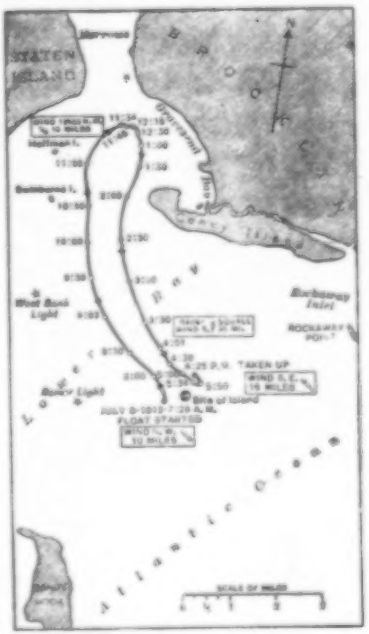
Total distance, flood, =0.76 miles in 0.87 hours
Average velocity .... =0.79 miles per hour
Maximum " .... =1.05 " " "
Total distance, ebb, =2.03 miles in 2.07 hours
Average velocity .... =1.08 miles per hour
Maximum " .... =1.77 " " "



FLOAT 79, JULY 3, 1913

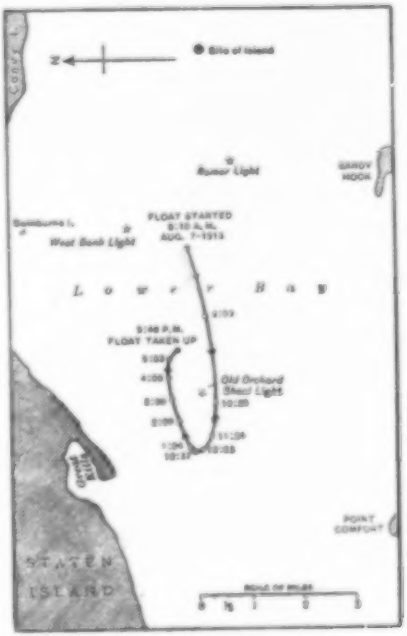
Total distance, flood, =0.75 miles in 1.0 hour
Average velocity .... =0.79 miles per hour
Maximum " .... =1.15 " " "
Total distance, ebb, =1.89 miles in 2.0 hours
Average velocity .... =0.76 miles per hour
Maximum " .... =1.20 " " "

Paths of Floats in the Lower Bay



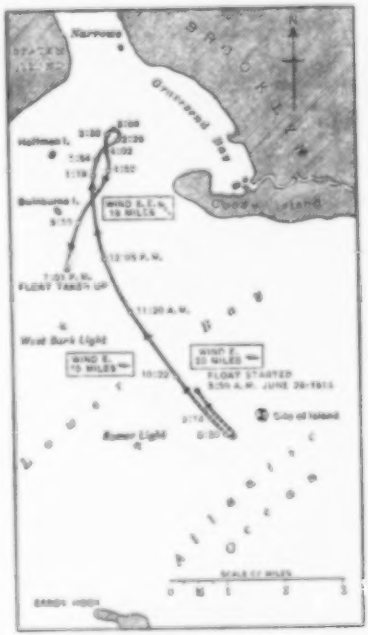
FLOAT 86, JULY 6, 1913

Total distance, flood, = 6.44 miles in 4.33 hours
Average velocity = 1.41 miles per hour
Maximum = 1.79
Total distance, ebb = 6.0 miles in 5.0 hours
Average velocity = 1.09 miles per hour.
Maximum = 1.79



FLOAT 90, AUG. 7, 1913

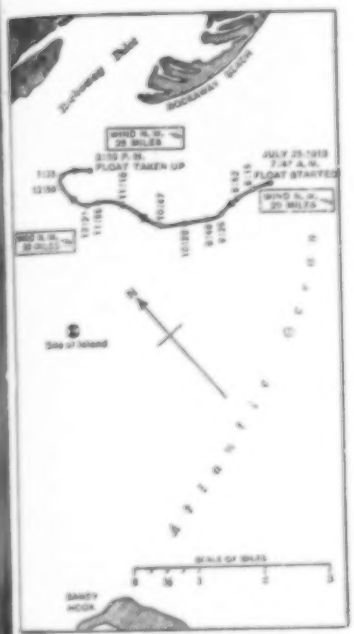
Total distance, flood, = 3.98 miles in 3.66 hours
Average velocity = 1.07 miles per hour
Maximum = 1.35
Total distance, ebb, = 3.21 miles in 3.73 hours
Average velocity = 0.39 miles per hour
Maximum = 0.61



FLOAT 78, JUNE 26, 1913

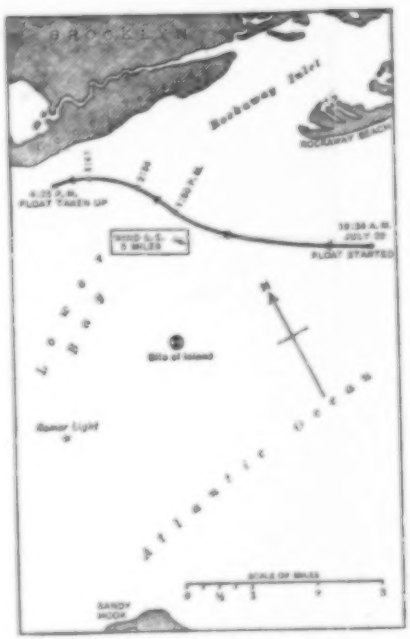
Total distance, flood, = 6.0 miles in 7.0 hours
Average velocity = 0.86 miles per hour
Maximum = 1.42
Total distance, ebb, = 3.53 miles in 4.0 hours
Average velocity = 0.83 miles per hour
Maximum = 0.95

Paths of Floats in the Lower Bay



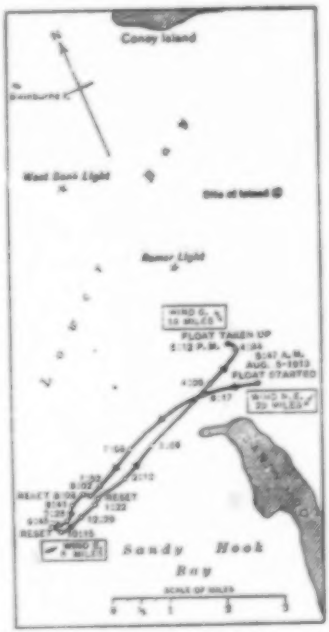
FLOAT 66, JULY 25, 1913

Total distance, flood, =3.80 miles in 5.80 hours
Average velocity . . . . =0.66 miles per hour
Maximum " . . . . =1.19 " " "
Total distance, ebb, =0.38 miles in 0.98 hours
Average velocity . . . . =0.41 miles per hour
Maximum " . . . . =0.41 " " "



FLOAT 86, JULY 29, 1913

Total distance, flood, =5.05 miles in 5.85 hours
Average velocity . . . . =0.86 miles per hour
Maximum " . . . . =0.96 " " "



FLOAT 89, AUG. 5, 1913

Total distance, flood, =4.33 miles in 3.87 hours
Average velocity . . . . =1.12 miles per hour
Maximum " . . . . =1.90 " " "
Total distance, ebb, =4.73 miles in 6.78 hours
Average velocity . . . . =0.70 miles per hour
Maximum " . . . . =1.45 " " "

Paths of Floats in the Lower Bay

at the end of this series made in 1913, that Mr. Robinson had charge of. I think those began on page 40, and the site of the island, the proposed island, is shown in the circle with two black sectors. There are several pages there which were done in 1913.

Q. Well, that part of the offer you have nothing to do with at all?

A. Nothing at all.

Mr. Riker: This offer is objected to for the reason that the witness does not undertake to say that it contains what it purports to contain, or is in effect ascertained by him or within his knowledge, and for the further reason that it is not within the purview of the order of March 10, 1910, made by the United States Supreme Court, and not being confined to the time indicated by that order.

609 The Commissioner: The objection of counsel for the defendants will be noted.

(Paper received and marked Complainants' Exhibit No. 226.)

(Here follows report marked page 609a.)

By Dr. O'Sullivan:

Q. Mr. Allen, how many men were on that boat during these experiments, and state how many tidal cycles some of those experimental float observations occupied?

A. There were usually an observer and a recorder, and two men besides the boat crew; and the engineer, and one or two men in charge of the boat. That varied a little, depending on the boat that we happened to have. The floats that were put in prior to 1909 were all done during one day. In 1909, the fall of 1909, we made some float experiments that extended over several days, night and day. We had a light on the float, and observers on a tug who followed the float, sometimes as much as three days.

Q. You mean continuous throughout the 24 hours in each day?

A. Yes.

Q. And having relays of men?

A. Yes.

Q. And did these men report to you on these various observations as to time and location of the float?

A. Yes.

Q. And did you cause these observations to be plotted in the diagrams that are contained in Exhibit 226?

A. Yes.

Q. Now, with regard to the observations at Robbins Reef, Mr. Allen——

610 A. We made a series of observations there in February, 1909, to get an idea of the currents. Those floats were not followed for any distance from the boat. The boat was anchored, and the velocity of the current was determined by the velocity of a float set out at the surface, or a certain distance below the surface, and timed with a stop watch, until it reached a certain point. The velocities that were determined in this way were as follows: A float set out 1 hour and 20 minutes, after high water, at Governor's Island, had a velocity of 1.2 feet per second on the flood——

Mr. Riker: One moment. This witness is reading from matter from a document, and is testifying without having been asked specific questions, and I ask the privilege of examining him on the document that he is reading from.

Dr. O'Sullivan: All right, sir.

By Mr. Riker:

Q. What is this paper that you handed me?

A. This is a transcript of notes from different sources of information.

Q. Notes made by whom?

A. By myself.

Q. And the sources of information were your own observations, were they?

A. These are different notes, the ranges of the tide, for instance,

were made by the Coast Survey. This particular subject that I am speaking of now was made by my personal observation, yes.

Q. What is that matter you are reading from?

A. The currents from Robbins Reef.

611 Q. The determination of the velocities of the floats that you were testifying to?

A. Yes.

Q. Were made by you personally from observations of the floats?

A. Yes.

Q. And the timing made by you?

A. Yes.

Q. And where are the original notes?

A. In the office of the Board of Estimate.

Q. And you have taken this summary from the original notes?

A. From my report to the President. At 2 hours and 30 minutes after high water at Governor's Island, on the ebb, the velocity was .6 per foot per second. At 2 hours and 50 minutes after high water on Governor's Island, the velocity was 2.2 feet per second. 3 hours after high water at Governor's Island, the velocity was 3.7 feet per second. 3 hours and 20 minutes after high water at Governor's Island, the velocity was .2 of a foot per second. 3 hours and 40 minutes after high water at Governor's Island the velocity was 2.6 feet per second. 3 hours and 50 minutes after high water at Governor's Island, the velocity was 2.2 feet per second. 5 hours and 45 minutes after high water at Governor's Island, the velocity was 2.8 per second. 40 minutes after the time of low water at Governor's Island, the velocity was 2.6 feet per second on the ebb. 2 hours after low water at Governor's Island, the velocity was 2.1 feet per second. 3 hours after low water at Governor's Island,

612 the velocity was 1.5 feet per second on the flood. 4 hours after low water at Governor's Island, the velocity was 1.9 feet per second. 4 hours and 15 minutes after low water at Governor's Island, the velocity was .3 feet per second. 4 hours and 30 minutes after low water at Governor's Island, the velocity was .7 feet per second. 5 hours after low water at Governor's Island, the velocity was 1.7 feet per second on the flood.

Those were made February 18th, 1909.

Mr. Riker: Just one moment. I would like to move, on the last statement made by the witness, to strike out that testimony, as not being within the purview of the order under which this testimony is being taken.

The Commissioner: Note the motion of counsel for the defendants.

Q. Do these velocities vary from year to year to any considerable extent?

A. Yes. They vary, depending on the amount of fresh water coming down the Hudson River, the land water.

Q. And within what range is that variation?

A. I do not think our experiments were carried far enough to determine that. We made other experiments there which are shown on this diagram, giving the velocity at 4 feet below the surface, 20

feet below the surface, and 40 feet below the surface, near Robbins Reef, through a tidal cycle.

Q. What do you mean by "a tidal cycle", Mr. Allen?

613 A. A complete period from one high tide to the next high tide, or from one low tide to the next low tide; in other words, 12 lunar hours. This diagram covers about ten hours in a full line.

The dotted part on the right-hand side is interpolated from the last observation to the beginning of the series. This diagram was not the result of one day's work. It was compiled from results found under certain periods of time on several different days. It was not feasible to carry on the work continuously during the entire cycle. They were taken between September 1st and December 10th, 1909. The time is shown in this direction from nought up to twelve hours, and the velocity at 40 feet below the bottom is shown by this curve. Each of these horizontal lines represents an additional foot per second; that is 1 foot per second, 2, and 3, showing the maximum velocity, was over 3 feet per second. The minimum was perhaps ⅓ of a foot per second.

Dr. O'Sullivan: I offer the diagram and the curves described by this witness in evidence, and ask that they be marked Complainants' Exhibit No. 227.

By Mr. Riker:

Q. What data did you personally gather as the basis of this offer, Mr. Allen?

A. I was present a part of the time, and not all the time, when those float experiments were made.

Q. And did you take the velocities personally, while you

614 were present?

A. Yes.

Q. How much of the offer involves your own personal observation?

A. I can not say, for I do not remember.

Q. How much—half of it?

A. I can not say.

Q. Have you any way of determining how much?

A. I think I can find out from the records.

Q. Where are the records?

A. In the office. I think I can refer to them and find them.

Q. Who prepared the diagrams on two sheets in this offer, who prepared them?

A. The second sheet was prepared under my direction. The first one, I think not.

Q. The second sheet is a graphic illustration of velocities, is it not?

A. Yes.

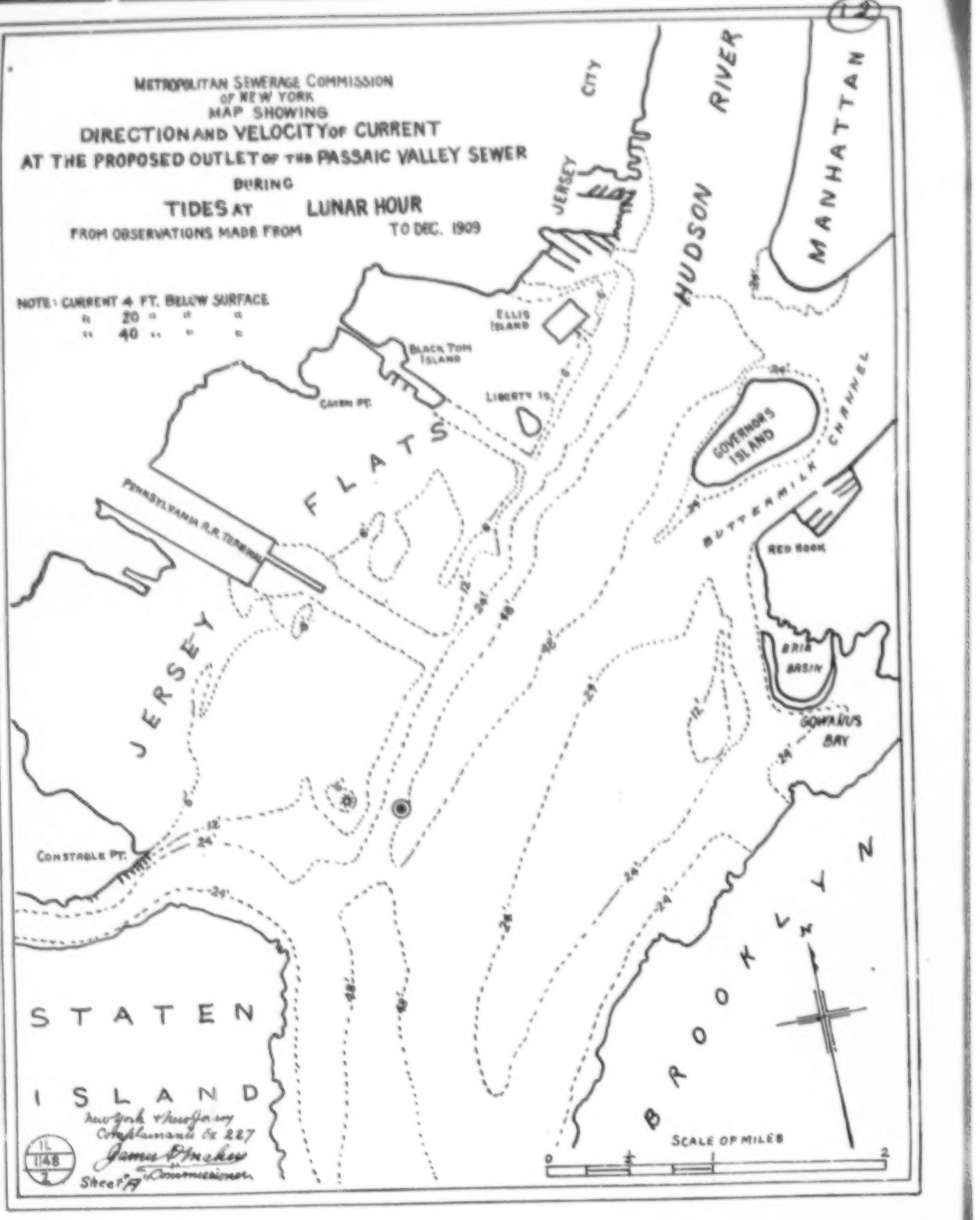
Q. Of which you furnished the data from your own personal observation as to a part, how much of it you do not know?

A. Yes.

Q. This was done in 1909?

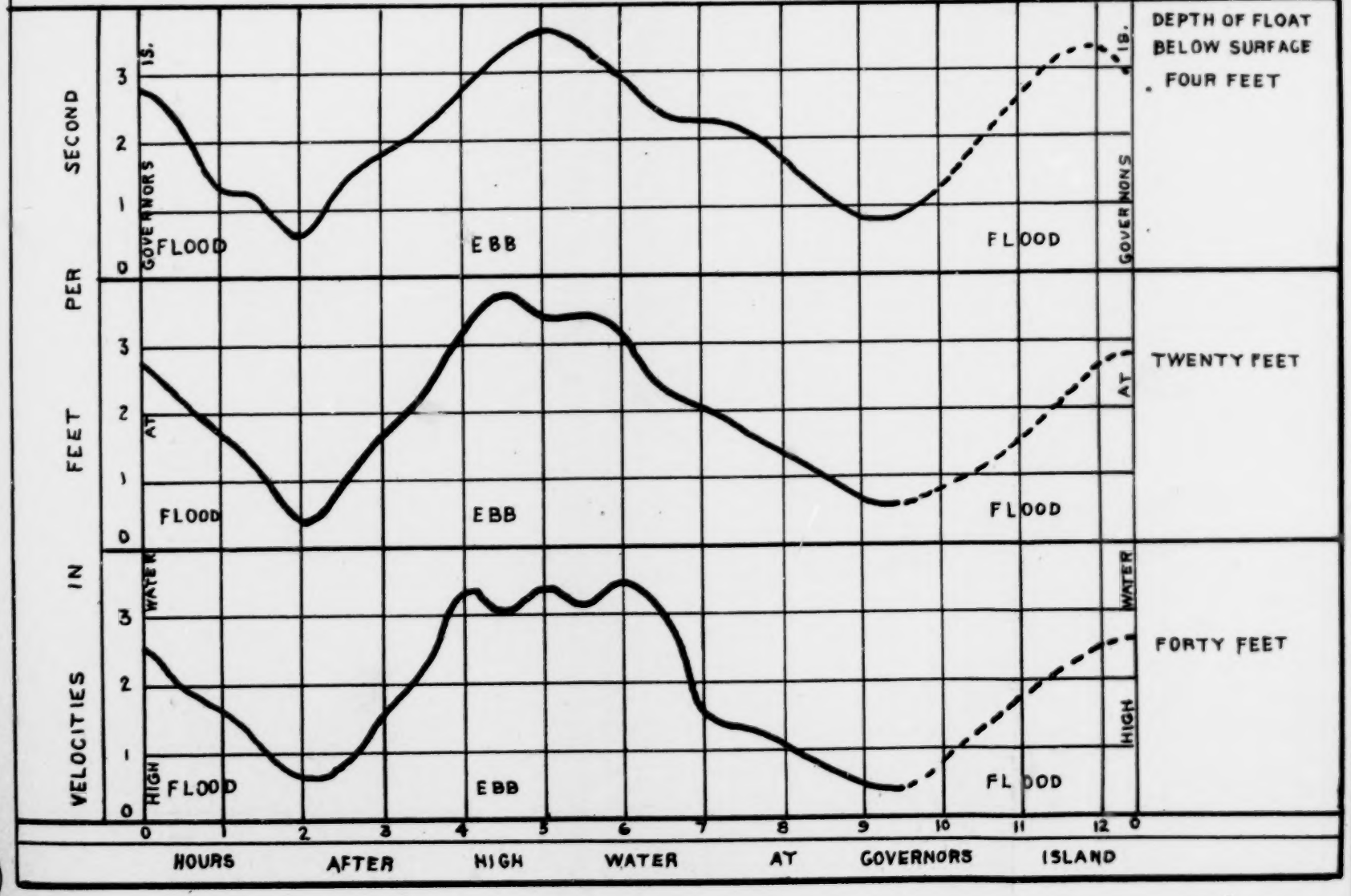
A. Yes.

Mr. Riker: The offer is objected to on the ground that it does


METROPOLITAN SEWERAGE COMMISSION
OF NEW YORK
MAP SHOWING
DIRECTION AND VELOCITY OF CURRENT
AT THE PROPOSED OUTLET OF THE PASSAIC VALLEY SEWER
DURING
TIDES AT LUNAR HOUR
FROM OBSERVATIONS MADE FROM TO DEC. 1909
NOTE: CURRENT 4 FT. BELOW SURFACE
" 20 " " "
" 40 " " "
JERSEY CITY
HUDSON RIVER
MANHATTAN
ELLIS ISLAND
BLACK TOM ISLAND
CAVEN PT.
LIBERTY IS.
GOVERNORS ISLAND
BUTTERMILK CHANNEL
RED HOOK
BRIE BASIN
GOWANUS BAY
PENNSYLVANIA R.R. TERMINAL
JERSEY FLATS
CONSTABLE PT.
STATEN ISLAND
BROOKLYN
SCALE OF MILES
0
1
2
New York & New Jersey
Complainants Ex 227
James D. Mahey
Commissioner
Sheet "A"
IL
1148
2

New York & New Jersey
Complainants Ex No 227.
James D Maher
" Commissioner
sheet "B"

VELOCITIES OBSERVED AT PROPOSED OUTLET, PASSAIC VALLEY SEWER
NEAR THE TIME OF SPRING TIDES
SEPT. 1ST TO DEC. 10TH 1909



ot represent the facts ascertained by the witness personally, which e can point out, and it is also confined to the year 1909, and is not ithin the purview of the order of March 10th, 1919, under which his testimony is being taken.

The Commissioner: The objection of counsel for the defendants ill be noted.

(The paper was received and marked Complainants' Exhibit No. 227.)

(Here follows map marked page 615*a*.)

By Dr. O'Sullivan:

Q. Mr. Allen, did you conduct any series of experiments or observations to determine the percentages of land water, and sea water, at various points in our harbor waters, and if so, state what you did?

A. The principal experiment was determining the land water at eleven points in the harbor three times a day, for over a year. That was done in co-operation with the light house service, who offered their assistance in making the observations. The work was done under my direction, and I have selected here the average results found at certain points of particular interest in this case for that year. At Passaic Light, an average amount of land water was 62.2 per cent. That was in the upper end of Newark Bay. At Fort Washington Point, Manhattan, in the Hudson, it was 66.3 per cent——

By Mr. Riker:

Q. What are you reading from?

A. I am reading from a transcript of the record.

Mr. Riker: I would like the privilege of asking some questions on this paper that the witness is using to testify from.

Dr. O'Sullivan: Yes, sir.

Q. Will you tell us what the paper is from which you are
616 testifying?

A. These records were made by the observer and handed in in note-books. Those note-books were taken by Mr. D. H. Merritt—I think his name was—who compiled and type-wrote the records and reported regularly to me. Those records are on file in the office of the Board of Estimate and Apportionment, and it was from those typewritten records of Mr. Merritt that these were copied.

Q. When were they copied?

A. A few days ago; I do not know what day.

Q. This is not a memorandum made at the time of the observations by you?

A. No.

Q. And do they represent any work done by you?

A. I had charge of that, that is all.

Q. In the charge that you had of the work, what did you do personally?

A. I did not take the observations. I reported on the results and compiled the results, and reported them to the President of the Commission.

Mr. Riker: I object to this witness using this paper to testify from, as neither being a memorandum made at the time, and being, on his own statement, a copy, and a mere hearsay as to somebody else's observations; also on the ground that it involves the de-

terminations alleged to have been made outside of the limits of the order under which this testimony is being taken.

The Commissioner: The objection of counsel for the de-
617 fendants will be noted.

By Dr. O'Sullivan:

Q. There were eleven stations in the harbor waters of New York for making the determinations as to the salinity or the percentage of salt, or sea water and land water, were there not?

A. Yes.

Q. And you were in charge of directing these observations, and the men who worked under you made the observations?

A. Yes.

Q. Did these men report to you?

A. No, the men reported to Mr. Merritt, and Mr. Merritt reported to me.

Q. And how often did he report to you?

A. Monthly.

Q. And from his reports, what did you create, as the result of his report to you?

A. I made various reports to the President of the Commission on the results obtained.

Q. And from your reports to the President of the Commission, have you copied and were reading off the figures and the locations that you have just testified to, and Mr. Riker asked you some questions about in cross-examination?

A. No. I took these from Mr. Merritt's original figures.

Q. Made to you?

A. Made to me, yes. At Blackwell's Island in the East River, 31.9 per cent. At Throgg's Neck, at the entrance to Long Island Sound, 18.1 per cent. At Robbins Reef, 31.2 per cent. At Robbins Reef, at slack water, the land water varied at different times throughout the year from 14 to 33.4 per cent, and at slack
618 low water, from 12 to 36.4. The average for the different months at Robbins Reef was: For January, 24.9; February, 46.2; March, 43.2; April, 56.1; May, 52.4; June, 34.0; July, 21.5; August, 21.4; September, 18.3; October, 19.6; November, 19.7; December, 22.3; showing considerable variation. A computation was made of the amount of water coming through the Narrows with——

By Mr. Riker:

Q. Have you finished with that paper?

A. The entire sheet, you mean?

Q. Yes.

A. Yes.

Mr. Riker: I want to know because I want to interject a motion to strike out all of the testimony of this witness, based on this paper which he has been reading, which was objected to by me as neither

being a memorandum made at the time, nor representing any facts within the knowledge of the witness, and also as being not within the purview of the order.

The Commissioner: The motion of counsel for the defendants will be noted.

The Witness: From the salinity observations at the Narrows, a computation was made of the amount of fresh water that went out on each tide, or rather the percentage of land water that went out on the ebb, and also what part of that had come down for the first time, and what part had come in previously on the flood,
619 and went out again. The same with regard to the sea water. This was done by using the Coast Survey volumes of discharge as a basis, and the salinity which was observed by the Metropolitan Sewerage Commission, and it was done for average conditions, and for dry weather conditions, as shown on this diagram here. The sea water is shown in green. The land water is shown in purple. The solid colors showing the new sea water and the new land water and the lower half of the diagram represents what came in and went out on the flood and the upper half showing what came in and went out on the ebb. For instance, on the ebb flood, under flood conditions——

By Mr. Riker:

Q. One moment; do you propose to testify as to the contents of this exhibit?

Dr. O'Sullivan: I offer this diagram that the witness has undertaken to describe, and I ask that it be marked in evidence as Complainants' Exhibit No. 228.

By Mr. Riker:

Q. Did you prepare this diagram?

A. Yes.

Q. From what date?

A. From the discharge volumes estimated by the Coast and Geodetic Survey, and from the salinity observations showing the amount of sea water, of the Metropolitan Sewerage Commission.

Q. Did you make any of these observations yourself?

A. No.

Q. Have you any knowledge as to their correctness?

620 A. I was not on the ground, and therefore it stands to reason that I have no direct knowledge of the observations.

Q. When were they made, if you know, of your own knowledge?

A. In 1909.

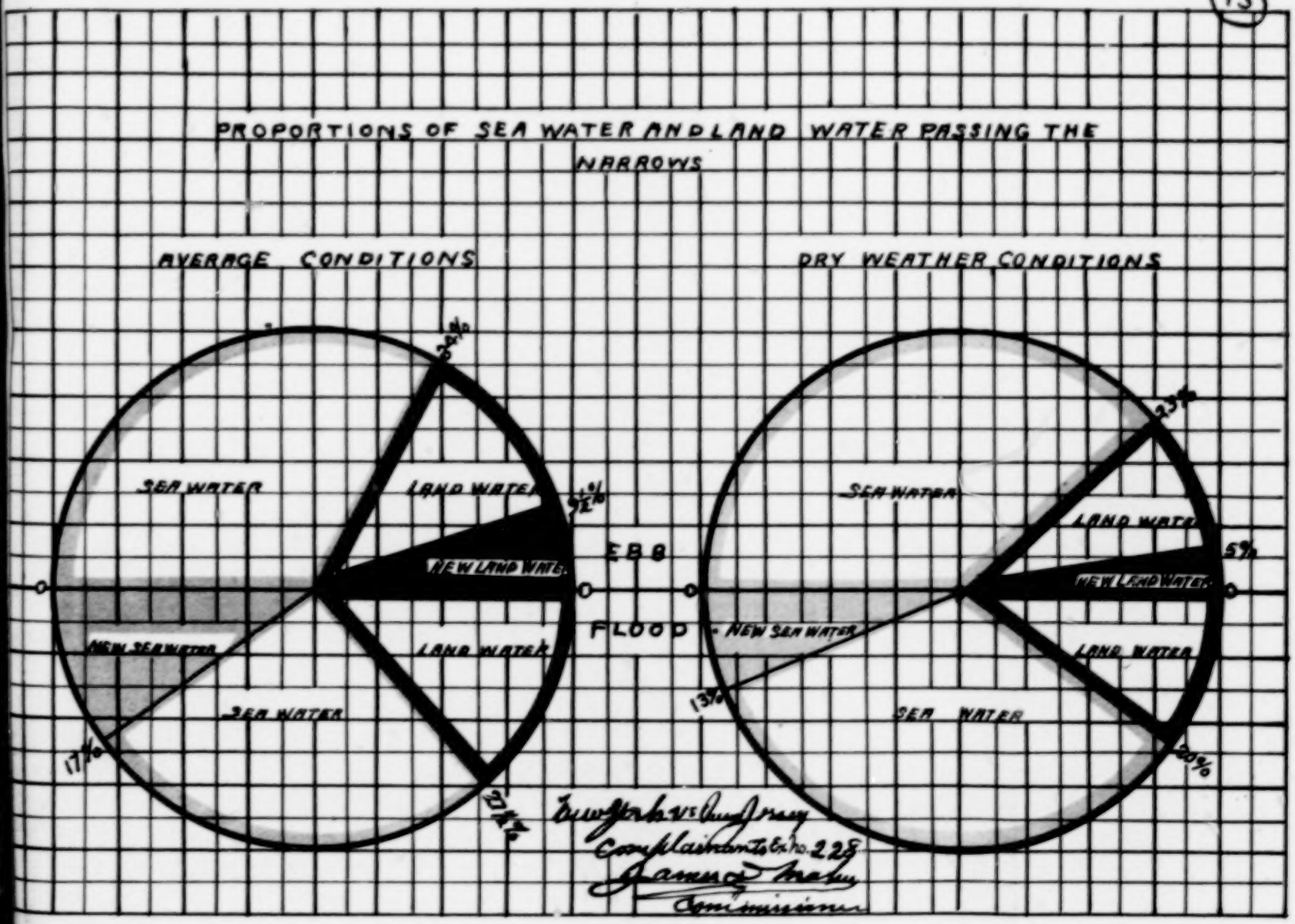
Q. How do you know that?

A. Because the observer reported to Mr. Merritt, and Mr. Merritt reported to me the results.

Q. In 1909?

A. In 1909, yes.

Q. How many observations does this purport to cover?


PROPORTIONS OF SEA WATER AND LAND WATER PASSING THE NARROWS
AVERAGE CONDITIONS
DRY WEATHER CONDITIONS
SEA WATER
LAND WATER
NEW LAND WATER
NEW SEA WATER
LAND WATER
SEA WATER
34%
9½%
27½%
17%
EBB
FLOOD
SEA WATER
LAND WATER
NEW LAND WATER
NEW SEA WATER
LAND WATER
SEA WATER
23%
5%
13%
20%
New York vs New Jersey
Complainant's Ex. No. 228
James D. Maher
Commissioner

A. Three a day for a complete year.
Q. Do you know whether, as a matter of fact, these observations were made, of your own knowledge; do you know it?
A. I know the record is in the book.
Q. That is all you know?
A. Yes.
Q. Mr. Merritt reported to you: that is all you know about it, is it not?
A. Yes.
Q. This is a graphic delineation of matter which was contained in the paper you were reading from just immediately, this testimony, was it not?
A. No.
Q. Partly contained in that paper?
A. No. That was with reference to Robbins Reef. This is at the Narrows.

Mr. Riker: The exhibit is objected to on the same grounds as the last exhibit.
The Commissioner: The objection of counsel for the defendants will be noted.

621 (The paper was received and marked Complainants' Exhibit No. 228.)

(Here follows diagram marked page 621a.)

By Dr. O'Sullivan:

Q. In your answer to Mr. Riker, Mr. Allen, you stated that Mr. Merritt reported on these observations to you, and that there were three observations a day for a year; is that correct?

A. Yes.

Q. And at how many stations were the observations made?

A. Observations were made at eleven stations, but this particular diagram has only reference to one station.

Q. And that station was there?

A. At the Narrows.

Q. Now, directing you attention to Complainants' Exhibit No. 228, will you state what the various colors and proportions there, and the circles relate to?

A. Taking the average condition on the diagram on the ebb current, those outlined in green indicate the proportion of this semicircle, which was sea water. That sea water had come in previously from the ocean and was passing out again. The part shown in orange was land water. That proportion of land water shown is 34 per cent of which 9½ per cent had come in on the previous flood and was going out again. Referring to the flood current on the lower side of the horizontal line, the green indicates the amount of sea water that came in on the tide, and of that the portion colored solid green indicates the sea water that had never come in
622 before, which was in this case 17 per cent. The land water coming in which had gone out previously and was not entering again, amounted to 27½ per cent.

Q. Mr. Allen, in your various observations and experimentations, to determine the percentages of land water and of sea water, in our harbor waters, have you ever discovered as a fact that there is a good percentage of land water at the bottom of our harbor waters?

Mr. Riker: Which is objected to as being leading; also on the ground that it does not appear that he has ever made any such examination; further on the ground that it does not appear that the examination was made, if made at all, and therefore not within the order.

The Commissioner: The objection of counsel is noted.

A. The amount of land water at the bottom is usually less than at the top. In general, the sea water predominates at the bottom. In the Lower East River, where the mixing is thorough, the difference is slight, and the entire stream is characteristic rather of sea water. In the Hudson, the difference between the top and bottom varies more, but the bottom water contains the larger amount of sea water.

The Commissioner: We will suspend for an hour.

(Recess until 2:00 p. m.

MAP

TOO

LARGE

FOR

FILMING

623 After Recess.

KENNETH ALLEN, resumed:

By Dr. O'Sullivan:

Q. Mr. Allen, what means of knowledge have you got with regard to the deposits of organic origin in the Upper Bay of New York?

A. The Metropolitan Sewerage Commission made a large number of borings in the bottom of the Bay at different points to examine the mud and the depth of the pollution. Those have been plotted on a map here, which gives the depth of the boring, and indicates by a solid red circle, the dot being after the figure, the depth to which the samples were polluted; and by a circle, half of which is solid, the depth to which pollution was questionable; and by an open circle no pollution was found. As a rule, in the Upper Bay——

Mr. Riker: Are you testifying from that map?

The Witness: I am not reading from it. I am referring to it.

Dr. O'Sullivan: I offer in evidence map of the harbor waters of New York, including the riparian land areas as described by this witness, and ask that it be marked Complainants' Exhibit No. 229.

By Mr. Riker:

Q. Did you make this map?

A. No.

624 Q. What part did you do?

A. None of it.

Q. Do you know anything about its accuracy?

A. Not from personal knowledge.

Q. Are there any facts stated here that are within your personal knowledge?

A. No.

Q. Did you make any of the borings that are supposed to be indicated here?

A. No.

Q. Did you make any determinations of the pollutions of the samples that were alleged to have been taken from the bottom of the Bay?

A. No.

Mr. Riker: The offer is objected to on the ground that it has not been proved.

The Commissioner: Note the objection of counsel for the defendants.

(The paper was received and marked Complainants' Exhibit No. 229.)

(Here follows map marked page 624*a*.)

By Dr. O'Sullivan:

Q. What are the appearances of the waters of New York Harbor, as far as your observations went?

A. Coming in from the ocean, you very often see a very marked line between the water of the Hudson and the ocean water; miles outside of Sandy Hook, you see a line almost as plain as the edge of the table showing where the fresh water, the land water, has come down without special mixing with the sea water below. That water might be termed clean and not offensive. Coming up the Narrows, and inside of the Narrows, there is a good deal of oil on the sur-
625 face, probably from the oil works at Constable Hook. Going up the Bay, there is a good deal of drifting material, but nothing of a particularly offensive nature, except along the shores in the vicinity of outlets, where there is more or less evidence of pollution. Going up the Hudson River, the pollution increases, and in certain slips, under certain piers, there are deposits which increase the pollution. Near the sewer outlet, the sewage frequently remains in a current by itself, well defined from the other river water, for many hundred feet from the outlet; and near the outlet feces and other evidences of pollution are frequent. But in the main channel of the stream, the water is not much more than turbid from the mineral matter held in suspension, brought down from above the City.

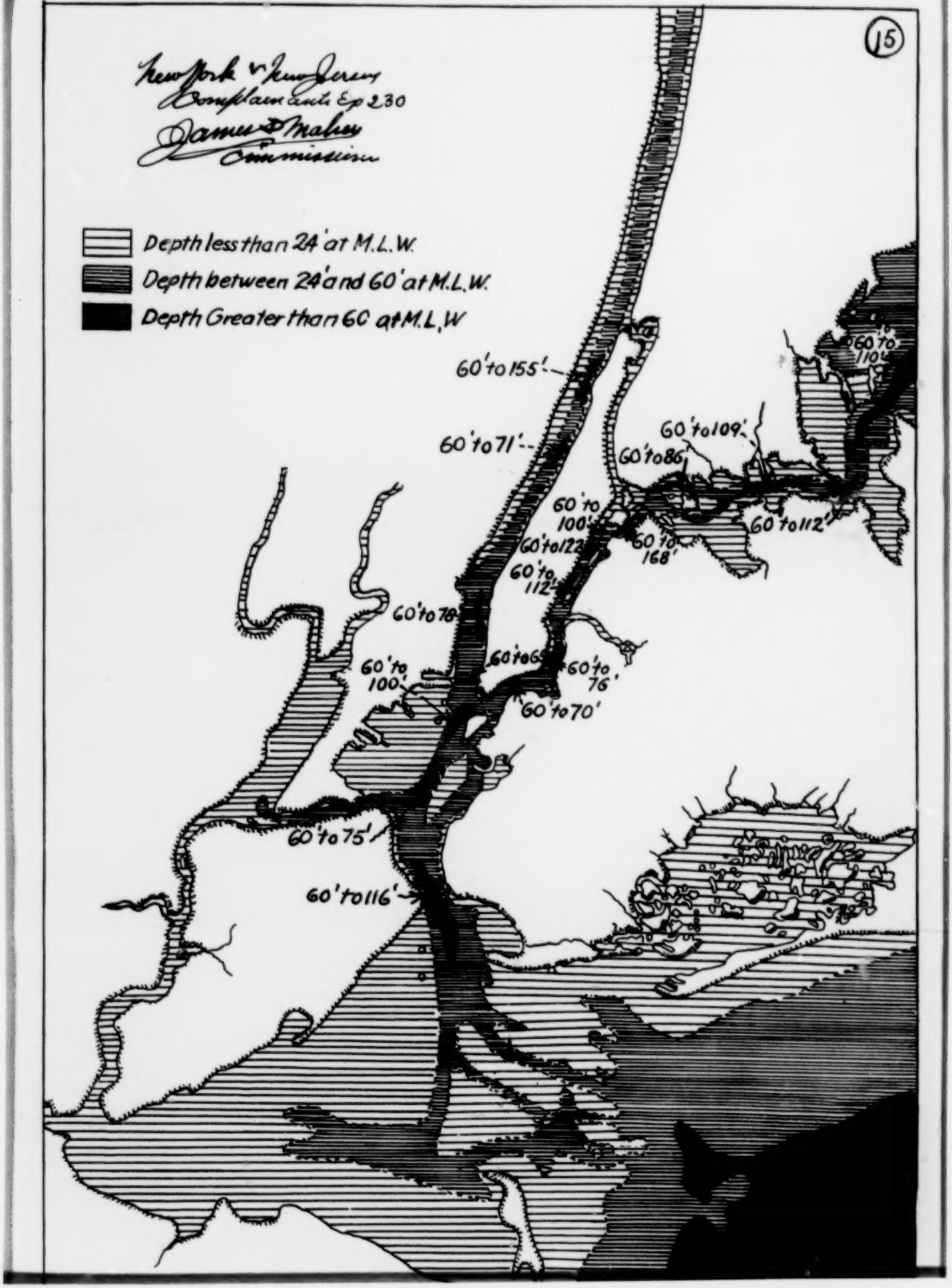
Passing from the Hudson up the Harlem River the pollution increases rapidly until at the southern end, near Willis Avenue Bridge, it is frequently very dark and turbid with oil, feces and other polluting material on the surface.

From the southern end of the Harlem River through Harlem Kills and Hell Gate, up the Upper East River to Throgg's Neck, the pollution decreases until at Whitestone Point the water is practically clean.

North of Riker's Island, however, chemical evidence has shown that the water is at times densely polluted. From Hell Gate
626 south through the lower East River, the pollution is very bad. At times there are fields of oil from one side to the other, and at times particles of pieces may be seen in the channel of the stream as well as around the sewer outlets.

Owing to the high velocity of the current, the bottom of the lower East River is quite free from deposit in spite of the pollution; but the conditions in general are worse than in any other of the main bodies of water, except the Harlem River. Generally speaking, there is more or less deposit to be found in both rivers near the shores, and in the Upper Bay east of the river from Constable Hook to Black Tom Island. The bottom of the Kill Von Kull and of Newark Bay, especially near Newark and near Elizabethport, also contain large deposits of putrescible matter. This map which I have shows the depth of the water in New York Harbor below 60 feet in white; between 24 feet and 60 feet in finely hatched lines; and in less than 24 feet in coarse hatching. This indicates that below the Narrows there is a natural bar cut only by the ship channels, which prevents

New York v. New Jersey
Complainant's Exh 230
James D. Mahon
Commissioner



to a certain extent, solid material brought down by the rivers from finding its way to the ocean.

Mr. Riker: Are you testifying from the paper now?

The Witness: From this map. I am referring to this, yes.

627 Mr. Riker: I think that ought to be offered.

Dr. O'Sullivan: We offer the map which this witness has just described as showing the various pockets and depths in the harbor waters of New York, and ask that it be marked Complainants' Exhibit No. 230.

By Mr. Riker:

Q. Who prepared this map?

A. The Metropolitan Sewerage Commission.

Q. Did you have anything to do with it?

A. No.

Q. Do you know whether it correctly represents what it purports to represent?

A. I know it is approximately correct.

Q. By that, do you know that the area marked in the solid white body is below 60 feet in depth?

A. Approximately yes.

Q. What do you mean by "approximately?"

A. Well, between, I should say between 10 and 15 per cent. I know that from my knowledge and my familiarity with the Great Survey charts.

Q. How do you know they are correct?

A. Not from my personal knowledge. I have never been down below.

Q. You have no personal knowledge about it at all?

A. The only personal knowledge we have is from where we have taken samples from below the surface and we have never found any great variation from the Government's charts. We have
628 done that at various places in taking sections of the Narrows, at the mouth of the Hudson, at the mouth of the Upper East River——

Q. You say "We have done it." Have you done it?

A. No, the Metropolitan Sewerage Commission.

Q. What do you know about it, if you did not do it yourself?

A. No more than that. I didn't do it myself, but what I mean to say is that this work was checked in that way.

Mr. Riker: The offer is objected to on the ground that it is not proven to be a representation of any facts within the knowledge of the witness.

The Commissioner: Note the objection of counsel for the defendants.

(The paper was marked Complainants' Exhibit No. 230.)

(Here follows map marked page 628a.)

By Dr. O'Sullivan:

Q. Were you on the staff of the Metropolitan Sewerage Commission when this map was prepared?
A. I was.
Q. As what?
A. As Engineer of the Commission.

Mr. Riker: Are you reoffering it, or is that just supplementary?
Dr. O'Sullivan: No; he has just referred to the exhibit.

Q. When you testify, refer to Complainants' Exhibit No. 230.
A. (Referring to paper:) The effect of this bar below the Narrows is made evident in work of the dredging of Ambrose
629 Channel by the United States Government. In doing that work, they dredged through many feet of black putrescible mud a short distance below the Narrows at the upper end of the Ambrose Channel, which gradually thinned out as they approached the location of this bar, and it finally disappeared. The condition of this mud was so offensive as to cause the men on the dredge to suspend work at one time.

Mr. Riker: Are you testifying from your own knowledge, Mr. Allen?
The Witness: I was told by the enginer that did the work.

Mr. Riker: I move to strike it out as hearsay.
The Commissioner: Note the motion of counsel for the defendants.

Q. Did you specially put questions to the engineer who was in charge of this dredging, to elicit that information?

Mr. Riker: The question is objected to on the ground that it is immaterial and irrelevant, and that testimony elicited in that manner is equally hearsay as if it were volunteered.
The Commissioner: Note the objection of counsel for the defendants.

A. Yes.

Q. In the discharge of your duties as engineer to the Met-
630 ropolitan Sewerage Commission, did you interview the engineer in charge of the dredging operations in the Upper Bay of New York, and elicit on questions, the information that you have now testified to?

Mr. Riker: Same objection.
The Commissioner: Note the objection of counsel for the defendants.

A. In the Lower Bay, I not only did that, but I visited the dredge in his company. The Metropolitan Commission made 1,100 examinations of mud which were not borings but dredgings; they were shallow dredgings of materials immediately on the bottom of the

harbor; and they found in the Kill Van Kull over eleven feet of polluted material, a large amount near the mouth of Gowanus Canal. There were large deposits along the shore at Hoboken and Weehawken on the west side.

Mr. Riker: I observe, Mr. Commissioner, that the witness is reading from a paper. I would like the opportunity to examine him as to what the paper is that he is reading from.

The Witness: These are my personal notes, my own personal notes. I am simply refreshing my mind from them.

Mr. Riker: Made when?

The Witness: I wrote these down yesterday, I think, but not from any other notes, they are simply my own notes.

631 Mr. Riker: I object to the use of the paper. The witness should rely on his memory. The testimony does not show that it is a memorandum made at the time.

The Commissioner: Note the objection of counsel for the defendants.

The Witness: This was told me by a man who was in the dredging business in Jersey City, who does a large amount of dredging, and his opinion was that this was largely material brought down from the Upper Hudson.

Mr. Riker: I move to strike that out. It is, on its face, hearsay.

Dr. O'Sullivan: I agree to strike it out.

The Commissioner: Note the motion of counsel for the defendants.

Dr. O'Sullivan: I agree with him to strike it out.

The Witness: There were deposits opposite the New York Dock Company's property in Brooklyn, at Main Street and Van Brunt Street, which were estimated by C. C. Hopkins, their Consulting Engineer, at 54,793 cubic yards, requiring removal annually.

Mr. Riker: I move to strike out the statement as being hearsay and not subject to verification on direct examination or on cross-examination, because the witness was not present.

The Commissioner: Note the motion of counsel for the defendants.

632 The Witness: There were many points beyond where the sludge deposits caused the evolution of gas in hot weather, and masses of solid matter would rise to the top, giving out very offensive odors. I have noticed particularly the East 106th Street outlet, Manhattan; and the conditions at the 110th Street outlet are particularly bad.

Speaking of nuisances, two or three years ago, in going up the East River in a Sound steamer, in warm weather, there was a distinct odor of sewage for a long distance, evidently owing to the pollution of the river in general, and not to some particular outlet. I was told by a man whose office was near the South 5th Street sewer outlet

in Brooklyn, that the stench in his office in warm weather was particularly strong at times of slack water.

Mr. Riker: I move to strike out the last statement as being hearsay.
The Commissioner: Note the motion of counsel for the defendants.

Q. Did you ask that man the questions yourself? Did you seek that information in your official capacity?
A. I asked him to find out what the conditions were, yes. At Oliver Street, Manhattan, the river pollution is particularly bad. The effluent was visible at one visit more than 150 feet from the pier. Feces were seen from the Roosevelt Ferry within 300 feet from the pierhead. The river which was in view, was very dirty off
633 Corlears Hook. Many feces were noted off Grand Street. The river was foul, dark and bubbling, and contained feces and thick scum off Division Street. In crossing at 23rd Street Ferry from midstream west, the river was very dirty with feces seen 300 feet off the 10th Street Ferry. Crossing again to Greenpoint, feces and oil were noted on the easterly side of the river.
Q. What was the condition of Newtown Creek during your tour of inspection?

Mr. Riker: When was that tour of inspection? Kindly give the date if you can.
Dr. O'Sullivan: He has made a number of them.

A. Newtown Creek has always been very badly polluted; and the Gowanus Canal also.
Q. Is there much commerce on Newtown Creek?
A. Yes, I have a statement here (referring to paper). The value of the traffic on Newtown Creek last year was $322,960,545.
Q. How does that compare with the Mississippi River?
A. I have a letter from the Mississippi River Commission, who give the tonnage.
Q. Dated when?
A. Dated August 1st, 1919; stating that for the calendar year 1918, the tonnage on that river was 4,693,102 tons. "A rough estimate of the value of the tonnage is $50 per short ton," which would give the value at that time as $234,655,000, which is considerably less than that of Newtown Creek.
634 Q. How much less?

Mr. Riker: That is a matter of calculation, I suppose.

A. $88,305,000.

Mr. Riker: I wish to note a motion to strike out the testimony with regard to the tonnage and the value of the tonnage on Newtown Creek and in the Mississippi River, as not being included within the scope of the order of March 10th, 1919, and as being immaterial and irrelevant.
The Commissioner: Note the motion of counsel for the defendants.
Dr. O'Sullivan: This line of testimony is urged on the ground

that the complainants are directed by order of the Supreme Court of the United States, on March 10th, 1919, to describe the present pollution of the waters of New York Harbor; and that in order to do that, and to satisfy the Court's inquiry as to what the City of New York is doing to rid itself of the complex problem of sewage pollution, it is necessary to have on this record some data relative to the enormous volume of commerce that is done, even in isolated parts of the harbor waters.

Q. Where did you get those figures that you have just read off in answer to my question?

A. I got the figures of Newtown Creek from the United States Engineer in charge of the First District of New York Harbor, Col. Edward Burr, Corps of Engineers, U. S. A.

635 Q. Where did you get the Mississippi figures?

A. The Mississippi figures I got from Wm. S. Prince, Secretary to Charles McD. Townsend, Colonel, Corps of Engineers, Mississippi River Commission, St. Louis.

Q. Are these official United States figures of the tonnage in the two water areas that you have compared?

A. They are.

Mr. Riker: I move to strike out the testimony on the ground that it is not the best evidence, as hearsay, immaterial and irrelevant.

The Commissioner: Note the motion of counsel for the defendants.

Dr. O'Sullivan: In reply to your motion, counsel for the complainants would like to state that the detailed figures are given in these communications, if counsel for the defendants wish them spread on the record.

Mr. Riker: The spreading of the details on the record would be equally hearsay, not the best evidence, and immaterial and irrelevant; it is therefore not desired by counsel for the defendants.

Q. Mr. Allen, in your present official position as Sanitary Engineer to the Board of Estimate and Apportionment of the City of New York, have you made reports relative to relieving the sewage
636 pollution in various areas of the harbor waters which concern the City of New York?

A. I have.

Q. Who is the Chief Engineer of the Board of Estimate and Apportionment?

A. Nelson P. Lewis.

Q. Were your reports made to Mr. Lewis?

A. Yes.

Q. Were they published in the Report of the Chief Engineer, Mr. Nelson P. Lewis, on the 15th of July, 1918?

A. My report on oxygen——

Q. I did not ask you about the oxygen; I asked you about your other reports.

A. I do not think there are any others of mine that I know of.

Q. What date is his report?

A. July 15th. This last report here is my report (indicating), and this is his report.

Dr. O'Sullivan: Read to the witness my last question.

(Question repeated as follows: "Were they published in the report of the Chief Engineer, Mr. Nelson P. Lewis, on the 15th of July, 1918?")

Mr. Riker: Objected to on the ground that the witness has answered it twice.

The Commissioner: Note the objection of counsel for the defendants.

A. One report was, but not all my reports.

Q. How many reports did you make to the Chief Engineer?

A. I have made a good many. I do not know.

Q. Did he embody some of them in his report of July 15, 1918?

A. Yes, sir, one of them.

637 Dr. O'Sullivan: I now direct your attention to the Report of the Chief Engineer of the Board of Estimate and Apportionment, embodying reports of this witness. I desire to have read into the record, from page 16, beginning with the words "drainage plans" to page 18, just before the heading "Grade Crossing Elimination".

Mr. Riker: Is the part of this printed publication referred to by counsel for the complainants the report that you referred to when you said that one of your reports was embodied in this?

The Witness: No.

Mr. Riker: I object to the offer to read this on the ground that it appears that the offer is something which the witness says is not his report.

Dr. O'Sullivan: You can see that his name is mixed in there.

The Commissioner: Note the objection of counsel for the defendants.

Q. Did you make a report to the Chief Engineer of the Board of Estimate and Apportionment on April 23rd of 1917, or 1918?

A. Yes.

Q. What year was it?

A. 1917.

Q. Is that alluded to in the pages that I now indicate between pages 16 and 18, and as I have described them in the Report of the Chief Engineer of the Board of Estimate and Apportionment,

638 dated July 15th, 1918?

A. It is.

Dr. O'Sullivan: I offer to have that part of the report read in evidence.

Mr. Riker: You state, Mr. Allen, that it is alluded to. Is the report embodied verbatim in this volume?

The Witness: No, it is not.

Mr. Riker: Then it is objected to on the ground that the offer is

not what his counsel describes it to be, but is an analysis or summary of some other thing in that report made by another party.

The Commissioner: Note the objection made by counsel for the defendants.

(The part indicated by Dr. O'Sullivan is read into the record as follows:)

"Drainage Plans.

The problems presented during the year in connection with new drainage plans relating to different boroughs have been varied and difficult. The co-operation of the Borough Sewer Bureaus with this office has been continued with what are believed to be excellent results. Some of the proposed amendments to sewer plans have involved modifications in drainage areas and such changes undoubtedly cause more or less embarrassment in levying assessments for trunk sewers. The complications resulting from changes in drainage districts, where trunk sewers have already been built in one of the districts and the cost assessed, have been pointed out by the Board of Assessors, but it is difficult to avoid them in some instances. Drainage areas when first established are controlled by the topography and they appear to have been laid out intelligently, although in many cases their boundaries had to be fixed before street grades were finally established and in most instances when upper reaches of the watershed were undeveloped or very sparsely settled. It frequently happens that a real estate development takes place at upper end of a watershed and a number of houses are erected. These houses need sewers, but it is often impossible to supply this need owing to absence of outlets, the building of which, often through undeveloped territory, would involve great expense and require much time. On the other hand, in an adjoining district the trunk sewers may have been carried well up into interior of the district and cost of building them may have been already assessed upon drainage area. The new development being near the dividing line between drainage areas could by a slight change in grades of streets and sewers be transferred from one district to another so that it could be supplied with sewerage facilities at very slight expense and with little delay. There would result, however, some injustice, in that the recently developed territory has not paid any part of expense of the trunk sewers into which they would now drain and those who have carried the burden could not in justice be asked to pay entire cost of the trunks which are to be used by others who have made no contribution toward their cost.

"The problem is a very difficult one and yet those who have built homes and added to taxable values are entitled to sewerage facilities. Possibly a practical solution would be to assess such property with what would have been its proper share of cost of the long trunk sewers necessary to serve it had it remained in original drainage area, but that does not correct the injustice involved in allowing them possibly to over-tax a sewer in an adjoining district designed to accommodate only territory within that drainage area.

"Under date of April 22d, I submitted to the Board a special

report of Kenneth Allen upon the Main Drainage and Sewage Disposal of area tributary to Jamaica Bay. Topographically this is one great drainage district, notwithstanding the fact that it lies in two boroughs. The report considers several plans. The one which appeared to offer the most economical ultimate solution of the problem was that involving concentration of all sewage from the area bordering Jamaica Bay at Barren Island, where it would be discharged into the deep water and swift currents of Rockaway Inlet. It
641 is estimated that volume of sewage so concentrated might amount in 1960 to 300,000,000 gallons daily and the problem of disposal of that amount of sewage at one point might prove so serious as to require a modification of plan by diverting a considerable portion to other points in Jamaica Bay. The general plan proposed was, however, believed to be sufficiently flexible to permit progressive construction, leaving question of amount of sewage to be concentrated at Barren Island to be determined by future conditions and by improvements in art of sewage treatment and disposal.

"Mr. Allen has also prepared a report showing results of tests made to determine amount of dissolved oxygen in harbor waters during the last few years and deductions which might be drawn from progressive decrease in oxygen content of harbor water and the influence of such decrease upon future plans for sewage disposal. It is submitted as an appendix to this report."

Q. Did you report to the Chief Engineer of the Board of Estimate and Apportionment drainage plans?

A. I did.

Q. Will you turn to page 72?

A. Yes.

Q. Turn to page 74. Are those some of the drawings?

A. Yes.

Q. And that is the basis of the report, is it, that you furnished to the Chief Engineer of the Board of Estimate and Apportionment?

A. Yes.

642 Dr. O'Sullivan: I ask to have read into the record that part of the record of the Chief Engineer of the Board of Estimate and Apportionment, dated July 15th, 1918, between pages 72 and 77 inclusive, beginning with the words "Drainage Plans" on page 72, and ending with the tabulation on page 77.

By Mr. Riker:

Q. Mr. Allen, is that part of the volume that counsel has referred to your report?

A. Yes.

Q. Verbatim?

A. I think not. I do not know whether it is verbatim or not.

Q. You testified that it was?

A. No, I beg your pardon. I do not think I testified it was. It is not my report. It is based on my report.

Q. This is a report by somebody else?
A. This is a report by Mr. Arthur S. Tuttle, Deputy Chief Engineer to Nelson P. Lewis, Chief Engineer.
Q. It is his understanding of your report, is that what it is?
A. Yes.
Q. Where is the report?
A. At the office, on file.

Mr. Riker: The offer is objected to on the ground that it is not the original report of the witness, even if that were competent to be introduced of itself; that it is merely a resume or summary of the report as it was understood by someone else.

643 The Commissioner: Note the objection of counsel for the defendants.

(The report is read into the record as follows):

Drainage Plans.

"During no previous year have there been presented as many or as difficult problems relative to development or modification of Drainage Plan of the City. Early in the year the investigation concerning treatment of sanitary flow from territory bounded approximately by the backbone of Long Island, City Line, Atlantic Ocean and Ocean Avenue, comprising an area of nearly 50,000 acres in Brooklyn and Queens, was completed and made the subject of a comprehensive report by Engineer Kenneth Allen. The plan developed for the mainland followed in general lines laid down in annual report of this office for 1908 with provision for a final discharge to Rockaway Inlet at Barren Island; for Rockaway peninsula the plan proposed was based on outletting entire sanitary flow into Rockaway Inlet opposite Beach 149th Street. A number of alternative projects were also analyzed, but the one selected was shown to possess superior advantages and more particularly on ground that it could be carried out in a succession of stages with a minimum of immediate interference with portions of system now in use and that it would lend itself to radical revision if at any time before completion the art of treating sewage should be so im-
644 proved as to permit of use of outlets along shores of Jamaica Bay. While this plan was limited only to removal of domestic sewage, it was proposed that pending development of those portions of Queens which are now and probably for a long time will be of suburban character, and where low property values would not permit of installation of a combined system without imposing assessment burdens of confiscatory character, to permit of temporarily using sewers for removal of storm water. A plan submitted by the Borough President for drainage of Jamaica section of Queens, which is now provided only with sanitary sewers of inadequate capacity, was subsequently the subject of a report with a recommendation that it be revised to harmonize more closely with general

project previously outlined, but action was deferred pending further discussion with Borough President.

"Another important study related to drainage of Midland Beach and South Beach sections of Richmond where necessity of providing sewers to remedy insanitary conditions was brought to attention of the Board by the Commissioner of Health. A large portion of the drainage area is at a low elevation and in part is meadow land. The natural attractions of beaches and comparatively low property values have resulted in a large bungalow development, and in absence of an official street plan this has been based wholly on maps prepared by owners of tracts which have been subdi-
645 vided with streets constructed at natural grade irrespective of its elevation. To avoid building damage and to minimuze the fill, a plan has been formulated by Borough authorities dependent upon construction of a canal or ditch extending inwardly from waterfront, designed to remove storm water and thus permit of construction of comparatively low level gravity sewers to carry surface run-off, the entire sanitary flow being pumped at a central collecting point, a portion of it being also subject to previous pumping, where after treatment it is to be discharged into Lower Bay. From analysis made in this office it was estimated that a storm water system of sewers could be constructed and carried to waterfront outlet without incurring expense greater than that involved under Borough plan, and that such design would also possess marked advantage over one based on use of drainage canals which would likely become a nuisance and could not be a benefit either from a commercial or æsthetic viewpoint. It has also been pointed out that construction of proposed canals with adjoining streets would have effect of placing twice the normal assessment burden on abutting property, which would in this case be compelled to assume entire cost of street improvements. This plan is still under discussion and has not yet been the subject of a formal report.

646 "As noted in report of last year, definite rules governing treatment of sewer outlets have been formally adopted by the Board, being designed to insure grades for trunk sewers adapted to application of treatment whenever proper time arrived without necessitating pumping, and discharge of sewage under proper conditions. These rules have since been uniformly observed and their effect will unquestionably be to minimize disturbance of built sewers when time arrives to introduce further improvements.

"A considerable number of the plans approved during the year have first been revised in important particulars as a result of examinations made in this office. One of the most important related to main trunk sewer for the Corona-Woodside section, draining an area of about 10,000 acres. As originally presented it formed a part of a general plan for that portion of the area for which tentative plans only had previously been approved and had been calculated on basis of the McMath formula, which had previously served as basis for determining sewer sizes in this Borough. The upper portion of this trunk having already been built, a storm water overflow at 43d street serving as temporary outlet, and the opera-

tion of rules governing grade to be fixed at permanent outlet at foot of Theodore Street in Long Island City, no latitude to permit
647 an increase in fall was available. The design was also based on introduction of additional storm water overflows at foot of 25th and Theodore Streets, with a substantial drop in head at each point of relief, in this respect following what has heretofore been common practice in designs of this character. After a number of informal discussions use of rational method for determining volume of flow was agreed upon, and plan as revised was limited to the waterfront trunk and auxiliary trunk connecting with Woodside section. At suggestion of this office it was also based on a practically continuous grade across the spillovers, thereby substantially increasing available head and correspondingly curtailing size of sewer. The calculations on which amended plans were based were conditioned on use of special sections, in recognition of which details of type of sewer to be used were incorporated on plan, in this respect forming a departure from previous practice but one which it is hoped will serve as a precedent for other similar designs. The profile of this sewer along line of Ditmars Avenue and 25th Street as finally designed is shown on accompanying drawing. At the junction of these streets it is joined by a tributary trunk sewer which enters from south. The hydraulic conditions to which design has been adapted are as follows:

648

	Sewer entering overflow chamber.	Sewer leaving overflow chamber.
Section	9′0″x8′3″	9′0″x9′10″
Gradient (per cent)	.070	.022
Max. Flow—cu. ft. per sec.	312	193
Depth of Flow—ft.	9.0	9.0
Velocity—ft. per sec.	4.4	2.5
3xMDWF—cu. ft. per sec. (Appr'x'te)	107	193
Depth of Flow—ft.	7.3	7.6
Velocity—ft. per sec.	1.8	3.2
MDWF—cu. ft. per sec.	42	73.
Depth of Flow—ft.	3.8	4.0
Velocity—ft. per sec.	1.8	2.0

"It will be noted that self-cleansing velocities will obtain during period of maximum flow, and that for mean dry weather flow the velocities compare favorably with those ordinarily provided for large waterfront interceptors when operated under similar conditions. The drop in hydraulic gradient while passing overflow chamber is principally induced by discharge of storm water over the weir. A plan was also submitted by the President of Borough of Queens for an area of about 8,000 acres comprising Flushing section and
649 territory to south and east, involving design of an important trunk sewer which is ultimately to be carried to an outlet in Long Island Sound at College Point. In many particulars the case is similar to that already discussed and it is understood that plan is

now being restudied along lines similar to those observed in design of Corona-Woodside trunk.

"In Manhattan the principal changes comprise a modification of plan for West 46th Street outlet to adapt it to general rules governing outlets and to permit located proposed treatment plant on private property near waterfront instead of in the marginal way and a radical revision in plan of territory now outletting at foot of Clarkson Street, comprising an area adjoining North River between Spring and West 11th Streets extending eastwardly approximately to Lafayette Street, with an area of 460 acres. In this section the existing combined sewers are old and largely broken down besides being of inadequate capacity and unsuitable depth. Under new plan the storm and sanitary flow are to be separated, the former being discharged at foot of Clarkson Street as heretofore while the latter will be carried to a treatment plant to be located at foot of Canal Street, which will also be ultimately utilized for disposal of sewage now outletting at foot of Canal and Vestry Streets. A plan has also been
650 adopted providing for relieving an area of about 260 acres, the greater portion of which is now outletted into East River at foot of East 21st Street, through provision of a sewer in Madison Avenue from East 25th to East 33d Streets and in East 26th Street from Madison Avenue to East River, in which district existing sewers have been established to be clearly inadequate in capacity, with result of occasioning serious flooding with even moderately severe storms. Under the plan the new outlet is to meet drainage requirements for a portion of district with area of about 140 acres, removal of which, together with provision of additional overflow at foot of East 22d Street, will, it is expected, bring desired relief for entire area.

"The most important change made in drainage plan for Brooklyn provided for amending plan for trunk sewers in a portion of Brownsville district, comprising area of approximately 1,200 acres, to more fully meet drainage needs and effect an economy in cost of construction.

"In the Bronx the changes made have generally been of a minor character, the only noteworthy modification consisting of a plan for the trunk sewer outletting at foot of Old Perry Point; these sewers are designed to drain an area of about 1,400 acres comprising
651 eastern portion of Westchester Creek watershed and will also provide a sanitary outlet for an area of about 400 acres north of Bronx and Pelham Parkway and east of Tiemann Avenue, involving necessity for pumping. Storm overflows in Westchester Creek are to be provided at foot of Latting Street and of Randall Avenue.

"In addition to plan for Corona-Woodside interceptor in Queens to which reference has been made, plans have been adopted for drainage of an industrial area adjoining southeasterly portion of Sunnyside Yard, for the low-lying area adjoining Newtown Creek between Greenpoint Avenue and Dutchkills Creek where sanitary flow will be pumped into Orton Street sewer, for revising plan for Laurel Hill section to permit excluding sanitary flow from Newtown Creek, and for temporarily outletting an area south of Main Line

Division of Long Island Railroad west of Constantia Place into Central Avenue sewer pending construction of trunk sewer required to connect it into 51st Street outlet to which it is designed to contribute. A plan was also submitted for removal of storm water from about 200 acres in Far Rockaway section which was also designed to receive drainage from about 22 acres in Village of Lawrence, in the latter particular modifying a plan previously submitted in 1913,
652 when attention was called to the fact that changes now proposed were desired by Lawrence authorities. Approval was withheld pending a definite adjustment which would permit calling upon the village to assume its share of cost of work.

"In Richmond a temporary drainage plan has been approved for what is known as Mariner's Harbor section, comprising about 280 acres south of and adjoining Staten Island Rapid Transit Railroad between Morning Star Road and South Avenue. It is proposed to ultimately outlet this district into Arthur Kill, but the trunk sewer and treatment plant required would impose a heavy tax on a large area now generally unimproved, where property is inactive and values low. Under approved plan, which is designated as temporary partly by reason of lack of a permanent outlet and partly because the majority of streets have not yet been incorporated on City Map, the district will be given an outlet through an adjoining the use of a pumping station. Objections were raised to the ing the the use of a pumping station. Objections were raised to the plan in this office on ground that it failed to make provision for drainage of an adjoining area for which sewers will probably be needed long before permanent plan can be carried out, and because areas intervening between this and an adjoining district were
653 omitted in order that property owners could here construct private sewers discharging into a system toward cost of which they had not contributed.

"Plans approved during the year and approximate acreage affected are given in following table, a considerable number consisting of modifications in previous plans:

Borough.	Maps approved.	Approximate acreage affected.
Manhattan	15	389
Brooklyn	12	556
The Bronx	20	426
Queens	26	2,906
Richmond	4	290
Total	77	4,567

(On page 74 appears an explanatory cut.)

By Dr. O'Sullivan:

Q. I direct your attention to page 97 of the Report of the Chief Engineer of the Board of Estimate and Apportionment dated July 15th, 1918, under the heading "Land for Sewers," and going from pages 97 to 99, ending at the heading "Waterways," and ask you if that was based upon reports furnished by you?

654 A. It was not based on reports. It was based on a study made by me of the sewerage of Mariner's Harbor.

Dr. O'Sullivan: I ask to have that read into the record.

By Mr. Riker:

Q. This last offer, is that in your words?
A. No.
Q. Where is your study?
A. On file.
Q. Where is the file?
A. In the Chief Engineer's office.
Q. Of the Board of Estimate and Apportionment?
A. Yes.

Mr. Riker: The offer is objected to on the ground that it is not sufficiently proved, and does not contain any facts within the knowledge of this witness, and is immaterial and irrelevant.

The Commissioner: Note the objection of counsel for the defendants.

(Pages 97 to 99 referred to by Dr. O'Sullivan are as follows:)

"Land for Sewers.

"For several years a project has been under consideration for construction of a sewerage system in Mariner's Harbor section of Richmond. Only a small portion of the territory is shown on
655 Final Map and the tentative plan for remainder was found to be inconsistent with position of streets actually in use to an extent requiring radical revision. The latter changes were made in part during the year as far as seemed practicable at this time, and the sewer project was given increased activity by necessity of providing homes for employees of the newly created ship-building industry located at adjoining waterfront, with result of a concerted movement of property owners of the locality to cede easements in such land as was to be traversed by the sewers with exception of two small parcels. Under resolutions adopted by the Board and concurred in by the Commissioners of the Sinking Fund the Corporation Counsel was authorized to accept these easements, but that there might be no delay in advancing the physical improvements in case any cessions were rejected as not conveying sufficient title, a resolution was adopted by the Board for acquiring all of them under formal proceedings, but with understanding that such parcels as were

accepted prior to confirmation or to vesting title would automatically drop out of the proceeding. In initiating this proceeding advantage was taken of amendment made in Section 396 of Charter through provisions of Chapter 698, Laws of 1917, by providing for imposing and collecting the assessment in connection with that in-
656 volved in carrying out the physical work. Land needed for the pumping station was acquired under reasonable terms by direct negotiation between the Comptroller and owner with a similar provision for assessing cost. The undesirability of acquiring sewer easements in public streets has heretofore been recognized, based in part on fact that cost of acquiring remaining title in street is not correspondingly decreased, and in part on account of resulting unfair distribution of expense, which in this case falls partly upon an entire drainage area instead of wholly upon property which actually benefits by the street, it being assumed that construction of a sewer represents an incidental use of a street sufficiently strong to justify its acquisition as for street purposes. The conditions existing in this particular case were, however, deemed to warrant the procedure observed. Maps have also been adopted showing easements in Netherland Avenue and in Schofield Street, The Bronx, to permit cessions by owners desirous of expediting sewer improvements. In 1911 a proceeding was authorized for acquiring title to Bensonhurst Drainage Canal and Coney Island Drainage Canal, to provide an outlet for storm sewers for a large adjoining area to the north. In 1912 negotiations were opened relative to exchange of land within lines of these canals for other City-owned property, the con-
657 sideration of which led the Board to request the Corporation Counsel to suspend further action in proceeding until negotiations had been consummated. The following period of inaction resulted in 1916 in an issue by the Court, on application of one of the property owners, of an order directing that proceeding be resumed and carried to completion, or amended or discontinued. This was followed near the close of year by directions of the Board that steps be taken to change plan for Bensonhurst Drainage Ditch to carry out modifications which had previously been the subject of its approval and the corresponding amendment of opening proceeding. In resulting investigation by this office it became apparent that carrying out of plan even with amendment then proposed would involve expense very much greater than originally anticipated, and that further modifications both in plan for canals and for adjoining streets could be made without disadvantage to the project in so far as it was designed to provide for drainage, but with effect of a very substantial decrease in its cost. The result of this study was communicated to the Borough President and it is understood is yet being considered by him. In this investigation it was pointed out that while the project to which commitment has been made related solely to provisions of an outlet for storm water flow, it has been
658 construed by property owners to carry with it an intent to provide a navigable waterway to connect Gravesend Bay with Sheepshead Bay, the cost of which, resulting from construction of bridges, and incidental changing of street grades, would add very

largely to expense and would probably place it so high as to be out of proportion to benefit to be derived. It was also noted that some changes proposed in the street plan seemed to be essential and of a character which should be undertaken before development had progressed to such an extent as to make them impracticable."

Q. I direct your attention to page 120 of the Report of the Chief Engineer of the Board of Estimate and Apportionment, dated July 15th, 1918, beginning with the word "Sewers" and ending on page 125 with the word "Grading"; and ask you if you furnished the material on which that report was based?

A. I furnished a part of it, not all. That is, different subjects were made studies of; most of them were made by me but not all; and those results were submitted to the Chief Engineer, but no report was made.

Q. Did he embody these results as you furnished them to him in this report?

A. He did.

Dr. O'Sullivan: I ask to have that read into the record.

659 By Mr. Riker:

Q. Was the matter furnished by you, for this part of this printed volume, in the form of a study?

A. Yes, in the form of a memorandum, or a study; there were different studies made at different times.

Q. How much of the matter that is now referred to by counsel that is to be read into the record, is your work?

A. He brings up the Canal Street sewer, that was my personal study. Unionport I had nothing to do with. Woodlawn Heights and Webster Avenue I had nothing to do with, nor with Long Island City. Carmine Street, Clarkson Street and West Street were studied by me. Paerdegat Basin and Fresh Creek Basin were not studied by me.

By Dr. O'Sullivan:

Q. Who were they by?

A. One of the other engineers under Mr. Lewis. The matters pertaining to interception and disposal sewage were turned over to me, but the small sewer extensions were handled by other engineers. Genesee Street was handled by me. Newton Creek and Maspeth were not. West 30th Street and East 42d Street I made studies of. 26th Ward plant and disposal at Barren Island I studied. I do not see anything else that I had anything to do with.

Dr. O'Sullivan: I ask to have it read into the record.

660 Mr. Riker: I object to the reading of this matter into the record as it appears now that comparatively a small part of it this witness had anything to do with or has any knowledge of.

The Commissioner: Note the objection of counsel for the defendants.

Q. The matters in that part of the report of the Chief Engineer to which I have just now directed your attention, Mr. Allen, and occupying that part of this printed report between pages 120 and 125, what was the portion and relation to the main intercepting sewer and sewage disposal systems that was apportioned to you and what to the connecting sewers, to whom were they apportioned?

A. The engineer who does that work is Mr. Arthur Tidd.

(Pages 120 to 125 referred to by Dr. O'Sullivan, are as follows:)

"Activity in sewer construction was particularly pronounced during 1917, the value of improvements for which final authorization was given having been exceeded only four times during period elapsed since 1902. The most conspicuous undertakings of this character which have been authorized comprise the sanitary sewers in territory north of Canal Street between Greene and Sullivan Streets with a pumping station near junction of Canal and
661 Thompson Streets, and the reconstruction of a large number of broken-down sewers of which the most important was one in East 12th Street between 2d Avenue and Avenue B, Manhattan; the construction of Ralph Avenue trunk sewer as well as substructure of pumping station at outlet into Paerdegat Basin and such incidental dredging as required, the Ocean Avenue storm water trunk sewer leading to Sheepshead Bay together with a number of its tributaries, the sprinkling filter plant for treatment of sewage concentrated at 26th Ward disposal works, a number of tributary trunks and laterals in territory adjoining Sea Beach Railroad, and a few laterals in Brownsville section, Brooklyn; the extension of Boston Road trunk sewer to Corsa Avenue, a number of laterals in Unionport section, and provision of an outlet for East 235th Street sewer at Woodlawn Heights by connecting it into Webster Avenue system, The Bronx; and authorization of tributary trunks and laterals in Maspeth and Corona sections, a number of laterals in Long Island City, Broadway-Flushing, Fresh Pond and Woodside sections and of a sewer for drainage of Gutman Swamp, Queens.

"The most important projects to which commitment has been made through granting preliminary authorization comprise construction of Madison Avenue and East 26th Street relief sewers, reconstruction of sewers in 6th Avenue, Carmine, Clarkson and West Streets from West 14th Street to foot of Canal Street,
662 with a treatment plant at latter point, in Manhattan; construction of Remsen Avenue, Rutland Road and Kingston Avenue branches of system outletting at head of Paerdegat Basin, the Pitkin Avenue, Stone Avenue, Dumont Street and Williams Avenue trunks forming part of relief system outletting into head of Fresh Creek Basin, and a portion of Avenue U trunk sewer, in Brooklyn; the Appleton Avenue trunk sewer, with temporary outlet for sanitary flow into Westchester Creek at foot of Latting Street, and a trunk sewer in Eastern Boulevard between Fort Schuyler Road and Throggs Neck Boulevard, in The Bronx; the trunks of system outletting storm flow into Spring Creek through

open ditch in Genesee Street with temporary pumping station to discharge sanitary flow to 26th Ward disposal plant, the principal sewers required for Laurel Hill section with temporary outlet for sanitary flow into Newtown Creek, extensions of trunk sewers for Maspeth section, a number of laterals in Corona, Broadway-Flushing and Woodhaven sections, as well as for an area in vicinity of Degnon Terminal at Long Island City, and the Beaver Ditch drain, in Queens; and a system of sewers for Mariner's Harbor section, in Richmond, with a temporary outlet into Newark Bay through sewers already built in an adjoining area. The practice has been inaugurated during the year of making an independent in-

663 spection of Manhattan sewers for which reconstruction was proposed in all cases where evidences at hand as to their present condition were not supported by abundance of detail, and, as a result, authorization has been deferred in proposed new sewers in West 30th Street and in a portion of East 42d Street, where it seemed clear that conditions complained of could be corrected as a repair measure. The authorization of treatment plant at foot of Canal Street and of new tributary trunks comprised the first comprehensive undertaking in connection with proposed general reconstruction of sewers in this Borough, which project has been under discussion for many years. It is understood that selection of this point as first in the older portion of Borough in which treatment was to be applied was in part through established need of providing sewers of adequate size for the district as well as for replacing sewers in dilapidated condition and in part because of importance of this particular section of waterfront. Before its authorization, the Board was asked by the Borough President to establish some definite policy as to manner in which cost of treatment plants should be met, which question was referred to Committee on Assessments, pending report of which the improvement was authorized as one to be paid for by area of local benefit.

664 At close of the year the Committee advised the Board that arguments had been presented that the treatment of sewage was designed to improve condition of New York Harbor and for this reason such works as were required should be built at expense of the City; it pointed out, however, that the policy of requiring each drainage district to assume expense of caring for its own sewage appeared to be well established, but expressed belief that laying down a definite policy could not with propriety be undertaken at that time, but should be left to consideration of incoming Board. In recommending authorization of sprinkling filters of 26th Ward disposal works it was noted that the plant was later to be supplemented by installation of Imhoff tanks and additional screens, and that it should be considered as for temporary use only and up to a time when a proposed interceptor could be constructed to carry the sanitary flow of this and adjoining Borough to a proposed plant at Barren Island. The nuisance resulting from discharge of sanitary sewage from Woodland Heights section into Bronx River at foot of East 235th Street has been the subject of repeated complaint by the Bronx Valley Parkway Commission and by the Commissioner of

Health. The correction of this condition as provided for during the year by construction of connection with existing system on
665 opposite side of river will doubtless materially improve appearance of this picturesque stream. The 72d Avenue drain in Queens for which final authorization was given is designed to drain Gutman Swamp and adjoining lands comprising an area of about 130 acres; this improvement was carried out in compliance with request of the Commissioner of Health to remove a breeding place for mosquitoes. The drain is about a half mile long and will discharge into a branch of Flushing Creek. Construction of the Beaver Ditch drain in same Borough was originally proposed to correct an insanitary condition existing at Jamaica and repeatedly complained of by the Health Commissioner, but before information essential to its authorization could be presented to the Board it was understood that through clearing out and grading of old ditch the chief objections had been removed, and it was urged by this office that expensive temporary construction proposed to be deferred until a drainage plan for territory had been prepared and work could be carried out along permanent lines. In 1916 a resolution was adopted providing for charging to Repaving Fund the cost of work incidental to readjustment of old basins and inlets as incident to change made in radius of curb corners or where roadway widening was involved, providing that such cost did not exceed $100. Difficulties
666 were experienced in complying with this resolution to remove which it was modified during the year to withdraw the limitation as to expense and to provide that cost of new basins and inlets required to replace those in bad condition should be made subject of assessment. As a result of application by owners of three large properties for relief from assessment in construction of sewers outletting at foot of North 12th Street, Brooklyn, an investigation was made as to method observed in distributing cost. The improvement was designed as an outlet from sanitary flow from a large area in Brooklyn and Queens, and for carrying storm flow from territory in Brooklyn. A portion of district served was previously without sewers, while in other sections capacity was inadequate, and in preparing plan it was necessary to readjust boundary of districts for which trunk sewer assessments had already been paid so as to include them in the new one created. The varied conditions which obtained were recognized by Board of Assessors, which fixed the benefit as ranging from $9.25 to $7.00 per 100 square feet served and in proportion to benefit. Partly on ground that cost of work had been properly apportioned and partly because of inability of the Board to reconsider its determination to assess entire cost of improvement upon benefited area, the Board declined to favor the petition.
667 Alleged obstructions of natural water courses in Richmond was the subject of an appeal to the Board that steps might be taken to bring about their removal; it was claimed that through action of certain individuals lines of natural drainage had been obstructed in such way as to cause flooding and in bringing about conditions complained of by the Health Commissioner. It was held by this office that there was no authority in the City or in private

owners to interfere with a natural water course unless plans had been legally adopted and put into effect providing for construction of suitable sewers, and that any such interference established a liability of the party responsible therefor for such damage as might result, from which it followed that the City was not in position to take remedial action unless it was the offending party or unless public property had been subjected to damage. The matter was referred to the Corporation Counsel who concurred in these views and further advised that the City has no authority to enter upon private lands for purpose of restoring original channels.

"The total mileage of sewers authorized during the year under resolutions providing for assessing entire cost upon areas deemed benefited is given in table shown on page 123, while complete list of improvements for which final authorization has been given
668 is shown in Table No. 10."

Q. On page 155, and extending to page 159, are series of tables in the Report of the Chief Engineer of the Board of Estimate and Apportionment, showing the number and estimated cost of improvements authorized during 1907, in relation to sewerage. What part of that work did you do?

A. I had nothing to do with that. That was tabulated by the clerk.

Q. From data furnished by whom?

A. I can not say as to that; I do not know.

Q. Directing your attention to page 189 of the Report of the Chief Engineer of the Board of Estimate and Apportionment, in July, 1918, I ask what part of the work you have done, beginning at page 189 and extending to page 199?

A. I had nothing to do with that.

Q. These related merely to sewers. Are they connecting or intercepting sewers?

A. No, any sewerage work done in the City, the work is tabulated outside of my office, the costs, data, and so forth.

Q. Directing your attention, Mr. Allen, to page 223 of the Report of the Chief Engineer of the Board of Estimate and Apportionment, and dealing with "Dissolved Oxygen, 1914-1918," who furnished that report that lies between pages 223 and 242?

A. I prepared that.

669 Q. And it relates to what subject?

A. Dissolved oxygen in the water of the harbor.

Dr. O'Sullivan: I ask to have that read into the record.

By Mr. Riker:

Q. Upon what is this report based?

A. That was based on examinations made in each year by the Board of Estimate and Apportionment. The first year, 1914, was made before I went with the Board.

Q. You had nothing to do with it?

A. No. The other years were under my direction.

Q. Taking the other years, and beginning with 1915, what part did you do personally in reaching the results that are embodied in this report?

A. The analyses were made by a chemist of the Board. I had nothing to do with them.

Q. Who took the samples?

A. The chemist and an assistant of his. He usually had two assistants.

Q. Who made the record of the taking of the samples?

A. The chemist made the record.

Q. Did you have anything to do with it?

A. No.

Q. What did you have to do with it?

A. I directed the work, I told them where to go, what to do, where to get the samples, how many to take, and what day to
670 go out, what boat to go on, and so on.

Q. You didn't have any actual part in the taking of them or the making of the analyses, or any tabulating results?

A. Well, I directed the tabulations. I do not think I did any tabulating myself.

Q. Is that true of the report, so far as it deals with oxygen determinations in 1916?

A. I beg your pardon?

Q. Is that equally true with the report, so far as it deals with 1915?

A. Yes.

Q. And 1916?

A. Yes.

Q. And 1917?

A. Yes.

Q. And 1918?

A. With 1918, as far as it goes.

Q. With 1917?

A. Yes.

Q. Have you any knowledge of the correctness of these results, any knowledge of your own?

A. Not as a chemist, no.

Mr. Riker: The offer to read is objected to on the ground it is not proven as a document which can be introduced and accepted in evidence, so far as this witness is concerned, and is mere hearsay, and does not embody any fact which is within his own knowledge.

The Commissioner: Note the objection of counsel for the defendants.

(Pages 223 to 242 were read into the record as follows):

671 "Dissolved Oxygen.

1914-1918.

September 14, 1918.

Nelson P. Lewis,
Chief Engineer.

SIR:

I submit herewith a summary of tests for dissolved oxygen made during 1917, together with comments thereon, which are believed to be of sufficient importance in relation to pollution of New York Harbor and future plans for sewage disposal to be made available at this time and placed on record.

Very respectfully,

KENNETH ALLEN,
Sanitary Engineer.

Report.

1. Significance and Value of Dissolved Oxygen Determinations.

It is well agreed that the most significant factor in estimating relative pollution of streams is the degree of saturation with dissolved oxygen. In a report to Chief Engineer of Board of Estimate and Apportionate by W. M. Black and E. B. Phelps, dated February 16, 1911, they say:

'The amount of dissolved oxygen in the harbor waters furnishes the most satisfactory criterion of the purity of these waters'; and in Final Report of Metropolitan Sewerage Commission, pre-
672 sented some three years later, they say:

'In the Commission's opinion the amount of dissolved oxygen which is present in a natural body of water affords the best means available for measuring the burden of pollution which has been put upon the water and gives a basis upon which to form an opinion as to the maximum quantity of sewage which the water can properly absorb.'

"So long as dissolved oxygen is present it is available for ixidation of impurities and the extent of its depletion is a measure of the degree of pollution. It is usually expressed in c. c. per litre, parts per million or per cent saturation. The two first show amount available for oxidation of sewage, and as 'parts per million' is more in accordance with modern American practice it is preferred. 'Per cent saturation,' which was used in the work of Metropolitan Sewerage Commission, is a convenient measure of degree of pollution. The per cent saturation depends not only upon amount of dissolved oxygen present but upon barometric pressure and salinity and temperature of the water. For instance, for complete saturation with barometric pressure of 760 m. m. we require following amounts of oxygen:

673

	Temp. fahr.	Dissolved oxygen expressed in C. c. per lit.	P. p. m.
Fresh Water	At 32°	10.25	14.6
	" 70°	6.4	9.1
½ Fresh and ½ Sea	" 32°	9.2	13.1
	" 70°	5.8	8.3
Sea Water	" 32°	8.2	11.7
	" 70°	5.2	7.6

That is to say: fresh water at 32° F. will hold about twice the amount of oxygen that sea water will hold at 70° F.

"Even after making due allowance for temperature and salinity we cannot judge of subsequent changes without knowledge of character of pollution; its avidity for oxygen due to its age and its bacterial activity, or its inert character due to sterility or inhibiting effect of cold or disinfectants. Although the ultimate demand of fresh sewage on dissolved oxygen may be much greater, the immediate demand will be lower than in case of a septic effluent.

"Moreover, the demand on dissolved oxygen will be increased on the one hand by putrefying deposits on bottom and decreased by absorption of air on surface and the release of oxygen by the algal and other forms of plankton in the water. Any prediction based upon computation is, therefore, difficult.

674 "It is an unfortunate coincidence that depletion of oxygen by putrefaction and other chemical changes, organic, and inorganic, takes place most rapidly in hot weather when streams are subject to drought and when water contains the least amount of oxygen at any degree of saturation.

"Summer conditions, or those of early fall, are those when nuisance from stream pollution is to be most greatly feared, and tests made at those times are of greatest value in judging necessity of remedial measures. A few days of actively putrefactive conditions in a thickly settled neighborhood, if liable to recur, might result in incalculable damage to property values.

"The determinations themselves, of dissolved oxygen, while of great value in estimating degree of pollution of a stream are, therefore, not as simple as would appear and should be interpreted with full appreciation of above considerations.

"And in interpretation of results the possibility of transient or limited local pollution should be taken into consideration. The samples whose tests are recorded below are believed in all cases to have been taken from main streams and far enough from sewer outlets not to be directly influenced by their discharge.

Results of Dissolved Oxygen Tests in New York Harbor.

675 "The first determinations of dissolved oxygen in the harbor were made in 1906 by New York Bay Pollution Commission. These were made between January 28 and April 1 and, therefore, are no criterion of summer or even average con-

ditions. In round figures results near the surface averaged as follows: *

1906.	Location.	C. c. per litre.
Jan. 28.	Narrows	7.0
	¾ mi. N. of Robbins Reef	7.6
Jan. 30.	Narrows	8.8
	¾ mi. N. of Robbins Reef	8.3
Feb. 17.	Narrows	6.7
Mar. 2.	Kill Von Kull	7.1
	East River, off Pier 28	7.0
Apr. 1.	East River, off Battery	8.8
	" " below Blackwell's Island	8.3
	Hudson River, off Grant's Tomb	9.2

These results are all so high as to require no comment.

"In 1908 the Royal Commission on Sewage Disposal issued a report on Pollution of Tidal Estuaries containing much original and valuable information on the relation of dissolved oxygen to pollution based upon investigations by Adeney and Letts, and the following year the Metropolitan Sewerage Commission took up
676 a somewhat comprehensive examination of the question as related to New York Harbor. These were continued in 1911, 1912 and 1913.

"In their review of this work the Metropolitan Commission call attention to the fact 'that all the waters surrounding Manhattan are becoming more contaminated as time proceeds and that the change as measured by the dissolved oxygen figures is rapid."**

"In 1914 the work of Metropolitan Sewerage Commission came to a close but tests showing progressive depletion of oxygen which had been noted have been continued, first by Sewer Plan Commission, then by Bureau of Sewer Plan, and since August 25, 1916, by Bureau of Public Improvements.

"The number of samples analyzed has been:

1914, 650; 1915, 388; 1916, 176; 1917, 480.

Of these the following may be said to comprise a series taken at selected points:

(* Rep. N. Y. Bay. Pol. Com. 1906.)

(** Re Met. Sew. Com. 1914, p. 642.)

677 TABLE I.

Average of All Samples Taken at Selected Stations.

	Number of samples and per cent saturation.			
	1914.	1915.	1916.	1917...
Narrows	4-67%	6-79%		14-70%
Robbins Reef		6-74%		16-63%
Hudson River:				
Pier A	34-66%	20-52%		38-55%
155th St.	4-42%	8-51%	Samples	24-52%
Spuyten Duyvil	4-80%	8-66%	taken only	.....
Harlem River:			between	
Morris Heights	16-50%	14-43%	June 1	22-43%
Willis Ave.	16-49%	4-36%	and Oct. 1.	26-36%
Throggs Neck	8-68%			
East River:				
23d Street	18-60%	14-48%		36-44%
Pier 10	34-55%	20-47%		40-50%

"These all show a reduction in dissolved oxygen during period of observation.

"In comparing averages for different years, however, due regard should be had to proportion of samples taken during cold weather, when saturation figures are normally higher. During the last four years the number taken has been as follows:

678

Year.	Total No.	No. from June 1 to Oct. 1.	Per cent
1914	650	517	80
1915	388	272	80
1916	176	176	100
1917	480	264	55

"From these figures the average of results obtained in 1917 is undoubtedly too high to afford fair comparison with results of the other three years.

"For this reason a series of warm weather averages, when most tests are made and when influence of pollution is greatest, is a more reliable index of general depletion that is going on. Such results are:

679 TABLE II.

Average of Samples Analyzed Between June 1 and October 1 at Selected Stations.

	Number of samples and per cent saturation.			
	1914.	1915.	1916.	1917.
*Total number of samples	517	272	166	264
Narrows	4–67%	4–79%	4–66%	6–63%
Robbins Reef	2–71%	4–72%	6–64%	6–50%
Hudson River:				
Pier A	22–52%	14–42%	24–47%	20–46%
155th St.	4–42%	6–39%	10–40%	12–37%
Spuyten Duyvil	2–77%	4–46%	10–51%	.....
Harlem River:				
Morris Heights	8–26%	10–25%	10–25%	12–25%
Willis Ave.	8–26%	10–22%	10–15%	14–13%
Throgs Neck	8–68%	.....	.....	6–58%
East River:				
23rd Street	8–42%	10–35%	12–23%	18–27%
Pier 10	20–39%	14–34%	20–31%	20–35%

"In this series is indicated a positive depletion of dissolved oxygen varying between 1% in three years at Morris Heights to 26% in two years at Spuyten Duyvil. The lowest averages in 1917 are
680 13% at Willis Avenue, 25% at Morris Heights in Harlem River and 27% off 23d Street, Manhattan, in East River.

"It will be noted that percentage of saturation in Hudson River opposite 155th Street is less than opposite Pier A in spite of relatively small pollution to be expected from the north as compared with that entering river from Upper Bay. That this is not entirely due to discharge from Harlem River would appear from the fact that in 1914 and 1915 the averages in that stream at Spuyten Duyvil are also higher than in Hudson River off 155th Street, although this is not the case with 1916 and 1917 samples. This unexpected result may have been due to temporary or erratic causes and it may be that a larger series of tests would give a different result.

"Grouped according to different bodies of water the results during four warm months are:

*From all selected stations certain ones of which only are given in the table.

TABLE III.

Average of Samples Analyzed Between June 1 and October 1 from Main Branches of the Harbor.

	Per cent saturation.			
	1914.	1915.	1916.	1917.
The Narrows	68	78	63	63
Uper Bay—Robbins Reef	71	72	64	50
Hudson River	50	43	46	42
Harlem River	30	28	24	22
Upper East River	50	..	..	47
Lower East River	40	33	26	29

681 "This table comprises samples from other stations not given in Tables I and II and confirms the marked depletion of dissolved oxygen which is taking place in entire harbor, and at a rate which may be roughly taken at 6% annually, a rate exceeding the increase in population of the City. These results are shown on Plate I.

"Although Tables II and III serve better as indices of increase in pollution of New York Harbor, a better index of approach to a condition producing a serious nuisance, if not a menace to health and welfare, is the actual minimum degree of saturation that may occur during most unfavorable conditions. This, for the stations already selected, is shown in

TABLE IV.

Lowest Percentage of Dissolved Oxygen Found at Selected Stations.

	1914.	1915.	1916.	1917.
Narrows	45 Aug. 4	54 Aug. 17	48 Sept. 7	46 Aug. 1
Robbins Reef	70 Sept. 23	58 Aug. 17	51 Sept. 7	42 Aug. 1
Hudson River:				
Pier A	31 July 28	25 Aug. 17	29 Sept. 1	25 Aug. 1
155th St.	36 July 23	22 Sept. 14	25 Sept. 1	20 Aug. 8
Spuyten Duyvil	64 Sept. 17	35 Aug. 10	28 Sept. 1	Aug. 22 .....
Harlem River:				
Morris Heights	6 July 21	8 July 21	0 Aug. 25 Sept. 22	1 Aug. 15
682 Willis Ave.	0 Aug. 11	6 Sept. 14	1 Sept. 1	0 Aug. 22
Throggs Neck	47 Aug. 13	.....	.....	45 Aug. 1
East River:				
23d Street	28 Aug. 11	19 July 21	8 Sept. 22	10 Aug. 15
Pier 10	19 Aug. 18	22 July 21	17 Sept. 7	19 Aug. 1

"This table shows that in Harlem River depletion is complete, at least for brief periods, that 10 per cent may be expected in parts of East River and 20 per cent in parts of Hudson River. With such low figures local and temporary nuisances along water front may be looked for at any time between middle of July and middle of September. It has been noted that minimum saturation does not always occur on hottest days. Probably extremely hot weather promotes bacterial activity not only in the water but in underlying mud and the resulting draught on dissolved oxygen does not reach its greatest effect for some days thereafter.

"The continued lowering of these minimum figures is shown graphically on Plate II.

"Samples taken near surface and near bottom seldom show same degree of saturation. As a rule there is more oxygen near bottom, though in Harlem and lower East Rivers the mixing action
683 seems to render saturation more uniform. An exception to rule is found in the Hudson at and above 155th Street. A possible explanation of the higher oxygen content near surface here is that it is due to preponderating effect of surface absorption, while as pollution due to City's sewage increases as we proceed downstream the excess oxygen near surface is rapidly consumed by bacterial agencies which, on account of tendency of sewage to rise to surface, predominate that part of the stream. A higher percentage near surface may also be in part due to 'underrun' of polluted sea water finding its way upstream, as pointed out by Metropolitan Sewerage Commission. Generally speaking, however, less oxygen is found near surface than below.

"In most cases, the current, whether ebb or flood, coming from cleaner source is seen to have most oxygen, but anomalous results are noted at the Narrows with 91% on ebb and 88% on floods in 1915 and 73% on ebb and 59% on flood in 1916; the Hudson off Pier A with 42% on ebb and 59% on flood in 1914; 47% on ebb and 38% on flood in 1915; 52% on ebb and 41% on flood in 1916 and 50% on ebb and 32% on flood in 1917; and Throggs Neck with 49% on ebb (westerly) and 63% on flood in 1917.

"In general these observations agree with those made previously by Metropolitan Sewerage Commission although depletion of oxygen is continually greater.

684 "Besides samples taken at selected stations mentioned, similar series were taken at other stations: Off 42d Street in East River, 106th and 151st Streets and at Spuyten Duyvil in Harlem River and Dyckman Street in Hudson River, of which results for 1917 are given in Appendix. Samples were also obtained at different depths on cross-sections at The Narrrows, the Hudson at Pier A, and at 137th, 155th and Dyckman Streets; one-half mile north of Spuyten Duyvil, Mount St. Vincent and Yonkers, lower East River at Pier 10, upper East River off Stony Point, Barretto Point, Clason Point, Old Ferry Point and Throggs Neck, most of these being taken in 1914.

"Numerous other determinations were made at different points. These indicate, for example, conditions in Buttermilk Channel, in

Gowanus Bay, and near 'A' Buoy off Liberty Island to be quite inferior to those at Robbins Reef; that oxygen figures are high in Long Island Sound at Harts Island and Stepping Stone Light; that depletion is greater near middle of Arthur Kills than at either end; that minimum saturation in Flushing Creek near the mouth may be less than 50% and that in upper East River west of Clason Point it is at times as low as from 10 to 20% with a summer average north of Rikers Island of but 30%.

685 "These deductions are, of course, subject to revision on account of limited number of tests upon which they are based.

"Samples in Jamaica Bay were taken in 1915, supplemented the following year by U. S. Public Health Service. These were published in a report to Chief Engineer of Board of Estimate and Apportionment of March 19th, 1917, on Main Drainage and Sewage Disposal of Area tributary to Jamaica Bay and will not be referred to further in this connection as Jamaica Bay presents a special problem quite independent of other parts of New York Harbor.

"In the summer of 1915 the U. S. Public Health Service made a sanitary survey of Arthur Kills and Raritan Bay* with special reference to cultivation of shell-fish and in that connection made a number of dissolved oxygen determinations. Between the mouth of Elizabeth River and that of Fresh Kills the saturation at one point was found to be under 35%, rising to about 47% in Newark Bay, 69% between Tottenville and Perth Amboy, and 89% in Raritan Bay off Great Kills. The results for Arthur Kills are somewhat lower than obtained — this bureau between May 1 and October 1, 1917 (71% at B. & O. R. R. bridge, 67% opposite Fresh Kills and 73 at Tottenville ferry**) but they were all taken in August

686 and probably more nearly at time of greatest depletion. They indicate marked pollution, probably mainly due to discharge of sewage from City of Elizabeth and Joint Trunk Sewer from Essex and Union Counties, N. J., and to various industrial wastes which, with domestic sewage, must be increasing at a rapid rate along borders of the Kills on account of development since the war. It seems probable that tonnage entering this stream will also increase rapidly for some years and unless preventive measures are taken its sanitary condition and that of bordering marshes will become correspondingly objectionable.

*Public Health Bulletin No. 86, Hugh S. Cumming, 1917.

**See Table VI.

Summary.

"By reference to report of Metropolitan Sewerage Commission for 1912 we see that since 1909 the percentage of dissolved oxygen has decreased in:

	From—	To—	A decrease since 1909 of—
Narrows	83%	63%	24%
Upper Bay	87%	50%	25%
Hudson River	72%	42%	42%
Harlem River	55%	22%	60%
Upper East River	86%	47%	46%
Lower East River	65%	29%	55%

That is to say, at the Narrows and in Upper Bay there is
687 about three-fourths the oxygen available that there was in 1909, but in Hudson, Harlem and East Rivers there is but half this amount left.

"The depletion in hot weather is yet more pronounced. Minimum figures have been observed in the:

Narrows of	46%
Upper Bay at Robbins Reef of	38%
Hudson River at Pier A of	20%
Harlem River at Morris Heights and Willis Avenue of	0%
Upper East River at Stoney Point* and Barretto Point** of	10%
Lower East River at 42d Street of	4%

"The condition in not only Harlem and East Rivers west of Rikers Island but in Hudson River is such at times that positive local nuisances may be anticipated any summer following extreme temperatures, and in southern half of Harlem River a general septic condition throughout the stream is likely to occur at such times. In Hudson River the supply of oxygen depends to a large extent on volume of upland water brought down from the north. A summer of extreme drought would intensify pollution on this stream to a marked degree so that condition in ordinary years cannot be taken as a criterion.

688 "Conditions Existing Elsewhere.

"It may be of interest to mention degree of saturation existing in several other well-known streams.

"In the Potomac below Washington, the 'minimum monthly per cent of saturation with oxygen near the outfall was 50%' in August, 1912. (Report Met. Sew. Com. 1914, p. 239.)

"In Delaware River at Philadelphia oxygen was reduced to less than 20% opposite center of city in summer of 1912, but after pass-

*August 20, 1914.
**August 21, 1917.

ing city the percentage rose by absorption from air from 30 to 80%. (Idem, p. 240.)

"The Metropolitan Sewerage Commission of New York made analyses of water in Boston Harbor in vicinity of the Moon, Deer and Nut Island outfalls in 1911. The worst sample, taken within 10 feet of Deer Island outfall, contained 53% oxygen, and the lowest near Nut Island outfall 83%, but samples taken 500 and 1,000 feet from Moon Island outfall contained 68%, and others, a mile distant, but 75%. (Idem, p. 323.)

"Examinations of various harbor waters were made in December, 1911, by N. S. Hill, Jr., D. D. Jackson and Theodore Horton.† At time visited there was found in:

Havana Harbor	0.0%	saturation
Baltimore Harbor	23.4%	saturation
689 New York Upper Bay	67.0%	saturation
Washington-Potomac River	82.0%	saturation
Tampa Harbor	60.3%	saturation
Savannah Harbor	86.0%	saturation
Jacksonville Harbor	88.4%	saturation
Charleston Harbor	90.8%	saturation

Regarding their studies they state:

"'In Baltimore Harbor, with an average dissolved oxygen content of practically 23, marked evidences of putrefactive action were apparent all over the harbor, notwithstanding that temperature of water at time of the examination was about 46° F.

"'In Upper New York Bay percentage of saturation of dissolved oxygen is 67, and there are no general evidences of septic action.

* * *

"'Local nuisances near sewer outfalls may exist, however, in harbors where average oxygen content is much higher than figures mentioned. At Jacksonville, where lowest percentage of dissolved oxygen recorded was about 64%, there was evidence of local putrefaction in vicinity of several sewer outfalls.'

"Investigations of Delaware River at Philadelphia in 1914 revealed that 'there was no nuisance to smell from river water notwithstanding that on Philadelphia side the water on an average never contained 20% of its completely saturated amount of
690 dissolved oxygen and single samples were frequently below 10% saturation.' In Schuykill River a saturation of 6.3% was found.*

"In Passaic River at Newark a total absence of dissolved oxygen was found by Metropolitan Sewerage Commission in September, 1909.**

"The Thames at London, which was once in a most objectionable state of putrescence, was greatly improved by — system of inter-

†Transcript of Record, State of N. Y. vs. State of N. J., 1916, Vol. V, p. 4335.

*Report on Treatment and Collection of Sewage, Philadelphia, 1914, p. 125.

**Report Met. Sew. Com., 1912, pp. 325, 329.

eption adopted some 60 years ago and, in 1892, by establishment of treatment plants. But in spite of these improvements the oxygen content has been again lowered so that by July, 1912, it averaged but 13.2% saturation opposite the Barking plant at low water and 10.1% at Blackwall (just above Woolwich) at high water, and a minimum of some 6% was recorded opposite the Crossness works. A letter from T. W. H. Biggs, chemist at this plant, dated February 10, 1914, stated 'it is not possible to take a more serious view than we do with reference to the low percentage of dissolved oxygen found in the Thames.'

"According to Rudolph Hering (Rep. Met. Sew. Com., 1914, p. 238) the Elbe at Hamburg during low water in summer has contained less than 40% of oxygen 'without causing the harbor waters to be objectionable.'

691 "G. W. Fuller states (Canadian Engr., June 19, 1913) that oxygen there is reduced to 20% under ordinary summer conditions, while in the Spree at Berlin 1 c. c. per litre is considered sufficient.

" 'Other chemists have noted that re-aeration of water takes place very quickly when it is exposed to air in thin sheets or is vigorously agitated, and that in some cases a few minutes' exposure suffices for solution of a large proportion of the quantity of oxygen required for saturation.'

"Experiments on rate of re-aeration have been made by Dibdin (Purification of Sewage and Water), Adeney (Rep. Royal Com. Sewage Disposall, V. App. VI), Whipple (Proc. Mun. Eng. N. Y., 1910), Copeland (Rep. Met. Sew. Com., 1914), Phelps (Rep. Black and Phelps to Board of Est. and Apport., N. Y., 1911), Ellery Transcript of Record, N. Y. vs. N. J. and Passaic Valley Sew. Com., Vol. V) and others. So many factors, such as temperature, wind, current, barometric pressure, salinity and existing degree of saturation enter into the problem and necessary technic is so refined that results of experiments are not always harmonious.

"The reoxygenation by aquatic plant life is a material factor in many situations, resulting in supersaturation figures. Mr. Kuichling (Idem, p. 191) mentions a case where, under strong sunlight, the water 'will absorb within a few hours fully three times as much oxygen as it is capable of taking from the atmosphere alone' and another where it may contain 'three times as much dissolved

692 oxygen as would occur in pure water of same temperature.' This phenomenon, also, is aside from main discussion of this report.

(The following note appeared at the bottom of the printed page just copied):

"NOTE.—A polluted stream recovers its oxygen content by re-aeration as it flows down stream, as had been observed in the Thames below London† in the Delaware below Philadelphia†, the Dee-

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*C. E. Gregory, Trans. Am. Soc. C. E., LXXVIII, p. 990.

†Report on Collection and Treatment of Sewage, Phila., Webster, Dutes-ton Stevenson, 1914, p. 127.

plaines below Chicago‡, the Potomac below Washington# and many other places. Often, as in the last case, this is largely due to vegetable growths. The subject is a large one, but as it is not directly in line with subject of this report it is not further dwelt upon.

"That amount of such re-aeration is relatively unimportant in case of New York Harbor is made clear by opinion of Professor E. B. Phelps that 'whereas the total amount of oxygen available for sewage oxidation has been placed at 30% of saturation, I find that the actual additions to this quantity of re-aeration is less than 1/10th of one per cent.'§

693 "Effect of Passaic Valley Sewer.

"A discussion of dissolved oxygen in waters of New York Harbor would not be complete without some reference to proposed discharge of an average of 223.4 mgd* into Upper Bay near Robbins Reef by the Passaic Valley sewer by the year 1940. Desmond Fitzgerald stated as his belief, in evidence before Supreme Court** that the discharge of sewage from Passaic Valley into Upper Bay at this point would 'reduce the dissolved oxygen dangerously all around its borders and in East River and it would inevitably destroy the safe margin of safety now existing in the central bulk of Upper Bay water • • •.

"'As there is now in and around the water of Upper Bay hardly enough margin for safety to take care of crude sewage now discharged into these waters in summer season, New Jersey should not be allowed to discharge the sewage of Passaic Valley at Robbins Reef because it will dangerously diminish dissolved oxygen in the water and this danger will increase with advancing years. • • • As dissolved oxygen in the water becomes used up the harbor will rapidly approach condition of an open sewer or cesspool, giving out bad-smelling odors and causing damage of one kind or another to every one navigating the waters.'

"From a consideration of conditions regarding pollution
694 and oxygen supply of the harbor it seems safe to say that discharge of over 200 mgd. of septic sewage at one point in Lower Bay will have a marked effect in lowering oxygen content and increasing a general pollution, especially in the bay itself, but any attempt to predict conditions quantatively would be valueless. The arguments have been fully set forth in evidence before Supreme Court of the United States in 1912 and it is understood that the matter will be brought before Ex-Justice Hughes for final settlement April 15 of this year. The decision reached will have a direct

‡Sewage Disposal, Fuller, p. 229.

§Bul. 104, Hygienic Lab., 1916. 147 acres of tidal flats were found to produce enough oxygen to oxidize 1 mgd. of sewage, p. 172.

‖Transcript of Record, N. Y. vs. N. J., and P. V. S. C., Vol. II, p. 1004.

*Kuichling, Transcript of Record, State of N. Y. vs. State of N. J. and Passaic Valley Sewerage Commissioners, Vol. II, p. 1402.

**Idem., pp. 1538, 1537.

bearing on degree of treatment necessary for the sewage of New York.

"A Standard Saturation of Dissolved Oxygen.

"In setting a standard for minimum percentage of oxygen to be permitted the object to be attained must be kept in view; if for protection of fish life, it is one thing; if the prevention of odors, it is another and quite different thing.

"According to Royal Commission on Sewage Disposal* (See next page for note regarding this asterisk) with harbor water containing 50% of sea water, the oxygen may be temporarily reduced to 3.45 c. c. per litre (54% saturation at 60° F.) without fear of injury to fish.

695 *(From preceding page) Rep. V. App. VI, p. 95.

Authorities quoted by the Royal Commission are:

Thudichum. Fish barely kept alive with from 25 to 30% saturation.

Noel Paton. Less than 2 c. c. per litre is prejudicial to young salmonoids.

Konig. Fish can tolerate 2.2 c. c. per litre or one-third the normal amount in flowing water.

Dibdin. Dace, gudgeon and minnows succumbed with 20 to 25% saturation. Recommends 50% as desirable.

Hoppe-Seyler and Duncan. If ½ saturated, tench are practically unaffected. If 1/9 to ¼, trout are rapidly and seriously affected. With greater depletion sluggish fish (tench) may live a while but probably not long. (Idem, p. 207.)

"G. Bertram Kershaw, who was Chief Engineer of the Commission, says in a recent article:*

" 'River water which even for a short time only contains about 1 c. c. per litre of dissolved oxygen, cannot be said to be capable of supporting fish life permanently. * * * It would appear possible that larger fish may be more affected by lack of oxygen than smaller ones of same species. * * *'

696 "Mr. Kershaw concludes from investigation of streams in England that 3 c. c. per litre is about the figure beyond which most fish will survive even in hot weather but he adds that 'Probably having regard to all factors, 3.5 c. c. per litre would be a safer limit to take'; that is, about 60% saturation at 70° F. in half sea water and half fresh water.

"Professor E. A. Lette states: 'When the dissolved oxygen falls below a point somewhere between one-half and one-third the air-saturation value, the water becomes highly dangerous for fish.' (Proceedings An. Congress Royal San. Inst. Belfast, 1911.)

"On the other hand Mackinaw trout have been taken from deep

*Some notes upon Fish Life in relation to River Pollution. Water and Water Engineering, Oct. 15, 1917.

water in Trout Lake and white fish from Green Lake, Wis., where dissolved oxygen was about 1 c. c. per litre. (Bul. XXII, Wisconsin Survey.)

"Quite a different view is held by W. M. Black and Earle B. Phelps in a report to Chief Engineer of Board of Estimate and Apportionment, dated June 7, 1910, in which they say:

" 'About 30% of this dissolved oxygen can be removed without practical detriment to limpidity of the water or its ability to support major fish life. * * * Should loss of oxygen be greater
697 than 50% the water becomes offensive and major fish life disappears. Septic conditions are reached when oxygen has been exhausted.'

"The Metropolitan Sewage Commission gave considerable attention to this matter and obtained opinions from several experts, all of whom considered a depletion of more than 50% as indicating a 'serious condition.' (Report Met. Sew. Com., 1912, p. 77.)

"Dr. W. E. Adeney believed that a sample taken not over 200 yards from a point of outfall should show at least 60 to 70% saturation.

"Desmond Fitzgerald was of opinion that 'sewage should not be allowed to reduce percentage of dissolved oxygen in water below 50%.'

"Professor C. E. A. Winslow recommended that saturation be maintained above 50%.

"H. P. Eddy recommended that 'Quantity of oxygen dissolved in the water at any place should not during any week in warm weather average below 3 c. c. per litre of water' (about 58% at 70° F. and with 60% sea water).

"The Commission itself approved this last suggestion and their position was in turn endorsed by John D. Watson (Report Met. Sew. Com. 1914 p. 183). Subsequently opinions were received
698 from Rudolph Hering and George W. Fuller.

"Mr. Hering did not recommend a uniform standard but considered 25% of oxygen 'with frequent sludge removal from harbor bottom a safe protection against any nuisance arising from the water' (Report Met. Sew. Com. 1914, p. 252). And Mr. Fuller believes 'a residual quantity of 1.5 c. c. per litre,' or one-half that recommended by Mr. Eddy is sufficient provided deposits of sludge on the bottom are prevented. (Report Met. Sew. Com. 1914, p. 213.)

"Messrs. Hill, Jackson and Horton, as result of their harbor inspections conclude that if saturation falls below a figure somewhere between 23% and 67% the nuisances resulting from putrefactive action will follow but that local nuisances may exist near outfalls with even high degrees of saturation. (Transcript of Record, State of N. Y., vs. State of N. J. and P. V. S. C., Vol. V, p. 4338.)

"Other opinions which have been expressed are as follows:

"W. J. Dibdin mentions relief from former distressing conditions in the Thames although dissolved oxygen at London Bridge was as low as 10% at high water, but observes that this does not permit fish to live, and stated as his belief after many years' observation that

there is little chance of their thriving with oxygen below 50%
699 and no chance for their surviving for long periods if below 30% saturation.

"Allen Hazen, to whom Mr. Dibdin expressed these views, endorsed them but observes that 'objectionable conditions in streams where they extend to the whole body of water are practically confined to places where dissolved oxygen is absent. (Proc. Munic. Eng. of N. Y., 1910, p. 196.) Prof. Phelps, on the other hand, says: 'I have time and again seen waters ranging from 25 to 40 or 50% of saturation which were positively offensive to the sense of smell' (Idem, p. 199) and Prof. Whipple says that 'He has at times observed unpleasant odors arising from a body of water where oxygen was reduced to about 20% of that required for saturation, but in these cases odors were apparently due in part, and perhaps chiefly, to putrefaction of sludge deposits on bottom of river. (Idem, p. 201.)

"Prof. R. Spurr Weston says: (Transcript of Record, State of N. Y. vs. State of N. J. and P. V. S. C., Vol. III, p. 1939)

"'I have made analysis and frequent careful observations of waters of Boston Harbor and have noticed offensive conditions where water was 70% saturated with oxygen and have never observed inoffensive conditions where dissolved oxygen was below 40%.'

700 "Dr. Dupres is of the opinion that:

"'As long as the oxygen remained about 25% or 30% of possible total there was no fear of any harm." Proc. I. C. E., Vol. CXXIX.

"In Berlin 1 c. c. per litre is considered sufficient but 1½ c. c. preferable. G. W. Fuller.

"25 c. c. per litre or 20% saturation is satisfactory in winter and 30% under summer conditions. Wisner & Pearse, Canadian Engr., June 19, 1913.

"'Theoretically, while dissolved oxygen remains there should not be putrefaction; practically any value below 50% of saturation is likely to be accompanied at times by malodorous conditions.' Sewage Disposal, Kinicutt, Winslow & Pratt, p. 38.

"'Those who have followed these matters most carefully in Europe and in this country feel that 30% is a reasonable margin as a minimum, and that for some species of fish a residual of 20% is not prejudicial for a limited area around point of dispersion.' G. W. Fuller, Sewage Disposal, p. 217.

"Perhaps the highest authority on the subject is the Royal Commission on Sewage Disposal. They classify their conclusions as follows, provided fish life is to be preserved (Rep. V. App. VI, p. 95):

701 "Class 1. Tidal waters whose currents suffice to transport all sewage matters from neighborhood of outfall 'and so widely distribute them through large volumes of sea water as to render them practically innocuous before change of tide.'

"Standard. The aeration of sample taken at ordinary low water in calm dry weather at any point 200 yards from outfall, if kept from 'contact with air for 12½ hours at 18° C. shall not fall below 2.8 c. c. oxygen per litre.'

"Class II. Tidal waters whose ebb currents transport liquid sewage matters after removal of solids and distribute them in the open water.

"Standard. *a*. Discharge on Ebb Only. The aeration of sample taken at beginning of 'the fourth hour of ebb of an average tide in calm dry weather at any point 200 yards from outfall' and 'kept out of contact with air for 6¼ hours at 18° C. shall not be less than 3.1 c. c. oxygen per litre.

b. Discharge at all Stages of Tide. Use standard for Class I.

Class III. All other tidal waters.

Standard. Discharge on Ebb Only. The aeration of sample collected as for Class II and 'kept out of contact with air for 48
702 hours at 18° C. shall not be less than 0.85 c. c. per litre, and subsequent rate of absorption shall not exceed 0.055 c. c. oxygen per litre per hour.'

It is difficult to reconcile such divergent views as are expressed above but the fact remains that standards of decency of the public regarding all such matters are being constantly raised. As stated by Professor W. P. Mason (Transcript of record N. Y. vs. N. J. and P. V. S. C., Vol. III, p. 2002):

" 'I have observed the higher standards demanded of late for good water, efficient sewage disposal, proper food, suitable ventilation and improved hygienic surroundings. In my opinion there will be in the near future more marked opposition to the further pollution of New York Bay than there is at present.'

"From personal inspection of conditions at points of discharge in Harbors of New York, Boston, Providence, Baltimore, Washington, London, Glasgow and Hamburg and in view of facts and opinions as set forth above, it is my opinion:

(The entire of the following three paragraphs was italicized in printed report from which this has been copied).

"1. That for preservation of major fish life the water should in general contain not far from 50% of dissolved oxygen.

703 "2. That putrefactive odors will not be produced in the water so long as there is a residuum of dissolved oxygen contained therein, but that they may exist to an objectionable extent in presence of dissolved oxygen: (*a*) by ebullition of gas from decomposing sludge deposits on bottom, or (*b*) by immediate discharge of large volumes of septic sewage.

"3. That to ensure a supply of dissolved oxygen at all points of a stream or harbor a liberal margin is required in main body of water, which, in case of New York, should not be less than from 30 to 50% saturation, depending upon intensity of local pollution due to sewage, septicity of the sewage, temperature of the air and to amount of sludge deposits on bottom.

"Referring in particular to Plates I and II, the deductions regarding necessity of protecting streams flowing past the shores of New York City from increased pollution are self-evident.

KENNETH ALLEN,
Sanitary Engineer.

TABLE V.

Dissolved Oxygen Analyses for the Year 1917; Selected Stations.

Station.	Number of samples.		Per cent saturation.						
				Average.					
					June to Oct. 1st.				
	Total.	June to Oct. 1.	Minimum and date.	All samples for year.	Top.	Bottom.	Ebb.	Flood.	Total.
East River—									
Midstream—Pier 10	40	20	19 on Aug. 1	50	36	34	38	30	35
Midstream—23d St.	36	18	10 on Aug. 15	44	25	28	30	24	27
Midstream—42d St.	32	16	10 on Aug. 15	45	26	26	28	25	26
Hudson River—									
Midstream—Pier A	38	20	25 on Aug. 1	55	45	47	50	32	46
Midchannel—155th St.	24	12	20 on Aug. 8 & 22	52	46	28	37	38	37
Midchannel—Dyckman St.	22	12	22 on Aug. 21 & 22	52	51	30	48	33	40
Harlem River—									
Midstream—106th St.	26	14	6 on Aug. 21	38	19	18	15	21	19
Midstream—Willis Ave.	26	14	0 on Aug. 22	36	14	13	17	11	13
Midstream—151st St.	24	12	0 on Aug. 21	41	23	21	6	38	22
Midstream—Morris Hgts.	22	12	1 on Aug. 15	43	24	25	15	45	25
Midstream—Spuyten Duyvil	22	12	3 on Aug. 15	51	34	32	32	35	33
The Narrows—									
Cross Section	42	18	46 on Aug. 1	69	59	66	63	..	63
Midstream	14	6	46 on Aug. 1	70	57	69	63	..	63
Upper Bay—									
Near Robbins Reef Bell Buoy	16	6	42 on Aug. 1	63	50	51	50	..	50
Throgs Neck—									
Midstream	6	6	45 on Aug. 1	..	58	57	49	63	58

TABLE VI.

Dissolved Oxygen Analyses for Year 1917, Miscellaneous Stations.

Station.	Total number of samples.	Per cent saturation.		
		Minimum and date.	Average.	
			For year.	June-Oct. 1.
Hudson River—				
Dyckman St.—Midstream	4	.....	75	..
Upper Bay—				
Mouth of Gowanus Bay	14	26 on Aug. 1	56	35
Near Bell Buoy 2G	18	40 on Aug. 14	62	52
Kill Van Kull—				
Midstream—B. & O. Coal Docks, St. Is	8	47 on Aug. 14	61	59
Midstream—Shooters Id. Fer. Slp	8	42 on Aug. 14	60	63
Arthur Kills—				
Midstream—B. and O. Bridge	8	53 on Oct. 31	67	71
Midstream—South Fork of Fresh Kls	8	47 on Oct. 31	62	67
Midstream—Ferry Sl'p at Tottenvle	6	62 on Aug. 14	..	73
Upper East River—				
Midstream—Bet. Lawrence & Stony Pt	6	14 on Aug. 21	..	37
Channel—Mouth of Flushing Bay	6	25 on Aug. 21	..	51
Midstream—Bet. Clason Pt. & Tallman Id	6	20 on Aug. 21	..	48
Midstream—Bet. Barretto Pt. & Rikers Id	4	10 on Aug. 21	..	36
Midstream—Bet. Old F'ry & Whitestone Pt	2	32 on Aug. 21	..	36
Flushing Creek—				
300' North of Broadway Bridge	6	48 on Aug. 21 Sept. 25	..	62

(On page 241, the page following, were four maps; on page 242, ten diagrams.)

708 By Dr. O'Sullivan:

Q. Was the chemist who performed those oxygen determinations in this room today, Mr. Carpenter?

A. He did those, if I remember correctly in——

Q. (Question repeated.)

A. It was done by different chemists, Mr. Carpenter, who was in this room, made a part of it.

Q. Do those oxygen determinations that you reported on, give full details in relation to the various samples tested, as to the numbers and locations?

A. They give the totals, but there are some details that were not printed in the Report.

Q. Have you got those details?

A. I have. These pages give the further details of the samples analyzed, and also include work which was done in 1918. They also contain some maps which were not reproduced in the report, which I handed in to the Chief Engineer with that report. There are four or five maps and one diagram and three pages of cross-sections, and another map.

Q. On these maps have you plotted the sampling locations with the percentage of the oxygen found at these stations?

A. Yes, with the average percentage of oxygen, and also the number of samples analyzed.

709 Dr. O'Sullivan: I offer this in evidence and ask that it be marked Complainants' Exhibit No. 231.

By Mr. Riker:

Q. Now, this is an offer of a series of blueprints—do these blueprints contain anything that you did yourself?

A. No.

Q. I think you said that they contained certain results. How do you know that?

A. The results were reported by the man that did the work.

Q. When you say they contained these results, you mean they were reported to you, and you believe they contained results?

A. Yes sir.

Q. Is that equally true of the year 1918, as of the other years?

A. Yes.

Q. These maps that are part of the exhibit, what did you have to do with them?

A. I directed their preparation.

Q. Did you have anything to do with the actual preparation?

A. No.

Q. So that in so far as the tables that are contained in this offer are concerned, you have no personal knowledge as to whether their contents are true or not—no personal knowledge, have you?

A. No, I have not.

Mr. Riker: The offer is objected to on the ground that the matter contained in it is not sufficiently proved, does not contain any statement of fact known by the witness to be correct, and
710 as being hearsay, immaterial and irrelevant.

The Commissioner: Note the objection of counsel for the defendants.

Q. Who directed the oxygen determinations made by the chemists?

A. I did.

(The paper was marked Complainants' Exhibit No. 231.)

(Here follow maps marked page 710a.)

DISSOLVED OXYGEN ANALYSES — File 3.6321 — 1

SELECTED STATIONS

STATION	NUMBER OF SAMPLES TOTAL	NUMBER OF SAMPLES June to Oct1st	PERCENT SATURATION MINIMUM and date	PERCENT SATURATION AVE. JUNE TO OCT.1st Ave. All Samples For Year	Top	Bottom	Ebb	Flood	Ave
			1914						
East River									
Cross Section-Pier 10	99	60	19 on Aug 18	55	37	43	42	37	40
Midstream - " 10	34	20	19 " " 18	55	36	43	43	36	39
" -23rd St	18	8	28 " " 11	60	40	44	44	42	42
42nd St	16	8	26 " " 11	58	35	42	42	35	39
Hudson River									
Cross Section-Pier A	98	62	28 on July 28	62	46	53	41	57	49
Midstream - " A	34	22	31 " " 28	66	49	55	42	69	52
Midchannel-155th St	4	4	36 " " 23		41	43	37	47	42
" -Dyckman St	4	4	44 " " 23		51	59	52	59	55
" -Spuyten D.	4	2	64 " Sept 17	80	89	64	77	--	77
Harlem River									
Midstream-106th St	14	6	16 on Aug 11	56	26	28	33	17	27
" -Willis Ave.	16	8	0 " " 11	49	25	28	39	16	26
" -Morris Hts.	16	8	6 " July 21	50	23	29	24	28	26
" -Spuyten D.	16	8	14 " Sept 17	63	39	38	50	27	38
Throgs Neck									
Cross Section	24	24	47 on Aug 13		66	72	68	70	69
Midstream	8	8	47 " " 13		66	72	63	63	68
The Narrows									
Cross Section	12	12	45 " " 4		65	71	68	--	68
Midstream	4	4	45 " " 4		57	77	67	--	67
Upper Bay									
Near Robbins Reef Bell Buoy	2	2	70 " Sept 23		70	71	71	--	71

Complainants Exhibit No 231
Sheet 1.

SELECTED STATIONS

STATION	NUMBER OF SAMPLES TOTAL	NUMBER OF SAMPLES June to Oct.1st.	PERCENT SATURATION MINIMUM and date	PERCENT SATURATION AVERAGE All Samples For Year	AVERAGE JUNE TO OCT. 1st. Top	Bottom	Ebb	Flood	Ave
			1915						
East River									
Cross Section-Pier 10	60	40	22 on July 21	46	32	37	35	35	35
Midstream - " 10	20	14	22 " " 21	47	32	35	33	34	34
" -14th St	14	10	21 " " 21	45	26	27	26	29	27
" -23rd St	14	10	19 " " 21	48	26	44	37	28	35
" -42nd St	15	9	23 " Aug 10	40	27	36	31	30	31
Hudson River									
Cross Section-Pier A	60	42	25 " " 17	52	40	43	45	53	41
Midstream - " A	20	14	25 " " 17	52	41	42	47	38	42
Midchannel-155th St	8	6	22 " Sep 14	51	46	32	46	24	39
" -Dyckman St	10	10	32 " " 14		56	41	46	48	49
" -Spuyten D.	8	4	35 " Aug 10	66	50	42	46	46	46
Harlem River									
Midstream-106th St	14	10	14 " Sep 10	46	22	27	26	23	25
" -Willis Ave.	14	10	6 " " 14	36	19	25	28	13	22
" -151st St	10	10	6 " Aug 10		19	28	24	23	23
" -Morris Hts.	14	10	8 " July 21	43	25	25	25	25	25
" -Spuyten D.	14	10	21 " June 24	56	44	43	40	49	43
The Narrows									
Cross Section	18	12	52 " Aug 17	78	70	86	93	62	78
Midstream	6	4	54 " " 17	79	69	88	91	67	79
Upper Bay									
Near Robbins Reef Bell Buoy	6	4	58 " " 17	74	68	76	82	63	72

Complainants Exhibit No 231
Sheet 2.

SELECTED STATIONS

STATION	NUMBER OF SAMPLES TOTAL	NUMBER OF SAMPLES June to Oct 1st	PERCENT SATURATION MINIMUM and Date	PERCENT SATURATION AVERAGE All Samples For year	AVERAGE JUNE TO OCT. 1st. Top	Bottom	Ebb	Flood	Ave
1916									
East River									
Midstream-Pier 10	20	20	17 on Sept 7		28	34	27	37	31
" -23rd St.	12	12	8 " " 22		21	24	12	33	23
" -42nd St.	12	12	4 " Aug 25		19	25	13	31	22
Hudson River									
Midstream-Pier A	24	24	29 " Sept 1		44	51	52	41	47
Midchannel-155th St	10	10	25 " " 1		50	30	42	39	40
" -Dyckman St	10	10	24 " " 14		56	34	48	43	45
Midstream-Spuyten D.	10	10	28 " " 1		63	40	57	48	51
Harlem River									
Midstream-106th St	10	10	5 " " 22		17	24	18	25	21
" -Willis Ave.	10	10	1 " " 1		16	15	17	12	15
" -151st St.	10	10	2 " " 22		23	26	9	49	25
" -Morris Hts.	10	10	0 " Aug 22		25	25	21	28	25
" -Spuyten D.	10	10	2 " Aug 25		37	28	27	40	32
The Narrows									
Cross Section	12	12	26 " Sept 7		58	49	74	53	63
Midstream	4	4	48 " " 7		56	76	73	59	66
Upper Bay									
Near Robbins Reef Bell By.	6	6	51 " " 7		57	69	65	61	64
1917									
East River									
Midstream-Pier 10	40	20	19 on Aug 1	50	36	34	38	30	35
" -23rd St	36	18	10 " " 15	44	25	28	30	24	27
" -42nd St	32	16	10 " " 15	45	26	26	28	25	26
Hudson River									
Midstream-Pier A	38	20	25 " " 1	55	45	47	50	32	46
Midchannel-155th St	24	12	20 " " 8&22	52	46	28	37	38	37
" -Dyckman St	22	12	22 " "21&22	52	51	30	48	33	40
Harlem River									
Midstream-106th St	26	14	6 " " 21	38	19	18	15	21	19
" -Willis Ave.	26	14	0 " " 22	36	14	13	17	11	13
" -151st St.	24	12	0 " " 21	41	23	21	6	38	22
" -Morris Hts.	22	12	1 " " 15	43	24	25	15	45	25
" -Spuyten D.	22	12	3 " " 15	51	34	32	32	35	33
The Narrows									
Cross Section	42	18	46 " " 1	69	59	66	63	--	63
Midstream	14	6	46 " " 1	70	57	69	63	--	63
Upper Bay									
Near Robbins Reef Bell By.	16	6	42 " " 1	63	50	51	50	--	50
Throgs Neck									
Midstream	6	6	45 " " 1		58	57	49	63	58

Complainants Exhibit No 231
Sheet 3.

MISCELLANEOUS STATIONS

STATION	TOTAL Number of Samples	PERCENT SATURATION MINIMUM and date	AVERAGE FOR Year	AVERAGE FOR June-Oct. 1st
	1914			
East River				
Midstream - 14th St.	8	27 on Aug 11	48	39
Hudson River				
Midstream - Desbrosses St.	8	32 " July 28		47
" - 14th St.	8	30 " " 28		46
" - 42nd St.	10	24 " " 28		40
" - 72nd St.	6	35 " Aug 18		55
" - 96th St.	6	35 " July 14		54
" - 129th St.	8	36 " Aug 11		57
Cross Section - 137th St.	14	33 " July 23		49
" " - 155th St.	18	25 " Aug 11	52	49
" " - Inwood	12	39 " July 23		54
" " - ½ mi.north of Spuyten Duyvil	12	31 " " 23		51
" " - Mt. St. Vincent	12	40 " " 23		57
" " - Yonkers Power House	12	52 " " 23		67
Upper Bay				
Buttermilk Chnl.-Midstr-Pier 30 Bkln	8	24 " Aug 18		39
" " " Atlantic Basin	8	23 " " 18		35
" " " Red Hook	8	26 " July 14		37
Mouth of Gowanus Bay	4	31 " Sept 23		43
Bay Ridge Chnl-off 53rd St. Bklyn.	4	37 " Aug 4		54
" " " " Bay Ridge "	4	41 " " 4		63
1000' off Bell Buoy "12BGF"	4	48 " " 4		66
200' " " " "26"	2	57 " Sept 23		64
Midchannel off "Red Post Lgt" Gov.Id	2	40 " July 14		40
Near "A" Buoy off Bedloes Id.	2	32 " " 14		36
South of Bell Buoy "1G1" off Govs.Id	4	35 " Aug 18		50
Near Red Spar Buoy 2 off Ellis Id.	6	37 " July 14		49
Upper East River				
132nd St.-300' from shore	2	25 " July 19		30
Truxton St.-500' off pier	2	25 " " 19		27
Tiffany St.-100' " "	2	25 " " 19		25
Farragut St.-300' from sewer outlet	2	37 " " 19		41
Cross Section-Stony Pt to Lawrence Pt	30	10 " Aug 20		29
Midstream - " " " " " "	10	12 " " 20		28
Cross Section-Barreto Pt to Rikers Id	20	24 " Sept 10		39
" " -Classon Pt to College Pt	5	53 " July 19		65
" " - " "to Tallmans Id	30	35 " Aug 13		54
Midstream - " " " " " "	10	35 " " 13		59
" -Old Ferry Pt to Whitestone Pt	8	37 " " 13		61
Cross Section " " " " "	24	28 " " 13		58
L.I.Sound-near Stepping Stones Lgt.	6	58 " " 13		82
- " Harts Id.	2	62 " " 13		74

Complainants Exhibit No 231
Sheet 4.

MISCELLANEOUS STATIONS

STATION	TOTAL Number of Samples	PERCENT SATURATION MINIMUM and date	AVERAGE For Year	AVERAGE June-Oct. 1st
	1915			
Hudson River				
Midstream - 155th St.	12	32 on Sept 14	52	46
Upper Bay				
Buttermilk Chnl-Midstr-Pier 30 Bklyn	2		59	--
" " " -Atlantic Basin	6	27 on Aug 17	52	47
" " " -Red Hook	4	55 " July 1	58	56
" " Near"A"Buoy SoendGovId	4	56 " May 14	69	76
Mouth of Gowanus Bay	4	37 " Aug 17	51	38
Bay Ridge Chnl-off 53rd St. Bklyn	2		73	--
" Bay Ridge "	4	38 " " 17	62	52
½ mi. west of Bell Buoy "12BGF"	2		81	--
Near Bell Buoy "2G"	6	55 " " 17	71	64
North of Buoy "14"	4	49 " " 17		61
Kill van Kull				
Off Constable Hook	2	56 on Sept 9		63
100' off Spar Buoy "2A"	2	44 " " 9		49
Off Shooters Id.	2	42 " " 9		45
Arthur Kill				
Off Elizabethport	2	40 on Sept 9		41
Newark Bay				
Off Bell Buoy "2"	2	45 on Sept 9		47
" Passaic Light	2	29 " " 9		31
" Buoy "13", Head of Bay	1	31 " " 9		31
Passaic River				
1000' east of D.L.& W. Bridge	2	0 " " 9		0
Hackensack River				
1000' north off C.R.R. Bridge	2	24 on Sept 9		24
1000' " " Morris Canal	2	20 " " 9		21
Jamaica Bay				
Off 26th Ward Plant Outlet	3	0 on Aug 20	17	2
At L.I.R.R. Bridge-Ramblersville	3	40 " " 20	70	57
Mouth of Bergen Creek	2	0 " " 20	46	0
Junction of Broad & Hassock Creeks	4	10 " June 17	70	50
Grass Hassock & Big Mucks "	4	80 " Aug 20		90
The Raunt-bet Ruffle Bar&Little EggMsh.	5	86 " " 20	96	94
½ mi.so.of Duck Pt-Big Fishkill Creek	3	86 " June 17	95	86
Big Channel off Long Paul Meadow	2		98	--
" " " mouth of Canarsie Chnl	2	90 " " 17	86	80
" " " -Rockaway Inlet	4	70 " Aug 20		85
Island Channel off dock	2	58 " " 20		62
Bedford Creek-2000' off mouth	2	59 " June 17		67
Beach Chnl-200' off Post Lgt-Rock'w'yIn.	2	84 " Aug 20		84
" " -Off Seaside	2	82 " " 20		83

Complainants Exhibit No 231
Sheet 5.

MISCELLANEOUS STATIONS Acc 2056

Computer W.I.FOSTER From 2055 to

Made in connection with Checker Date Dec 1917

STATION	TOTAL Number of Samples	PERCENT SATURATION MINIMUM and date	AVERAGE For year	AVERAGE June-Oct. 1st
	1916			
Upper Bay				
Mouth of Gowanus Bay	4	33 on Sept 7		42
Near Bell Buoy "2G"	6	44 " " 28		51
	1917			
Hudson River				
Dyckman St.-midstream	4		75	--
Upper Bay				
Mouth of Gowanus Bay	14	26 on Aug 1	56	35
Near Bell Buoy "2G"	18	40 " " 14	62	52
Kill Van Kull				
Midstream - B&O Coal Docks, Staten I	8	47 " " 14	61	59
" - Shooters Id. Ferry Slip	8	42 " " 14	60	63
Arthur Kill				
Midstream - B&O Bridge	8	53 " Oct 31	67	71
" - South Fork of Fresh Kills	8	47 " " 31	62	67
" - Ferry Slip at Tottenville	6	62 " Aug 14	--	73
Upper East River				
Midstream - Bet. Lawrence & Stony Pts	6	14 " " 21	--	37
Channel - Mouth of Flushing Bay	6	25 " " 21	--	51
Midstream - Bet. Classon Pt & Tallmans Id.	6	20 " " 21	--	48
" - " Barreto Pt & Rikers Id.	4	10 " " 21	--	36
" - " Old Ferry & Whitestone Pts.	2	32 " " 21	--	36
Flushing Creek				
300' North of Broadway Bridge	6	48 "(Aug 21 (Sep 25	--	62

Complainants Exhibit No 231
Sheet 6.

DISSOLVED OXYGEN ANALYSES 1914-1917 File 3.6321 7

Average for each stream - selected stations - June to Acc 2057

October 1st Computer FOSTER From to

Made in connection with Checker Date Dec 1917

STREAM	1914	1915	1916	1917
Hudson River - (Pier A, 155th St., Dyckman St., and Spuyten Duyvil)	50%	43%	46%	42%
East River - (Pier 10, 23rd St & 42nd St)	40	33	26	29
Harlem River - (106th St., Willis Ave., 151st St., Morris Heights., and Spuyten Duyvil)	30	28	24	22
The Narrows	68	78	63	63
Upper Bay - (Robbin's Reef)	71	72	64	50
Upper East River - (Throgs Neck, between Classon Pt. & Tallmans I., and between Lawrence & Stony Pts.)	50	--	--	47

Complainants Exhibit No 231
Sheet 7.

SUMMARY OF DISSOLVED OXYGEN RESULTS Acc 2565

WATERS AROUND NEW YORK 1918 Computer W.T.C. From to

Made in connection with ROUTINE STUDIES Checker Date April 29 1919

SELECTED STATIONS

SAMPLING POINT	NUMBER OF SAMPLES		PERCENT SATURATION						
				AVERAGE					
	TOTAL	June 1 to Oct. 1	MINIMUM and date	All Samples for year	JULY 16, 17, 18.				
					Top	Bottom	Ebb	Flood	Total
East River									
Midstr-Pier 10	10	2	18 July 16	65	22	18	20	--	20
Midstr-E.23d St.	8	2	15 July 16	60	15	17	16	--	16
Midstr-E.42d St.	8	2	26 July 16	62	26	26	--	26	26
Hudson River									
Midstream Pier A	8	2	45 July 17	67	58	45	51	--	51
Midchannel 155th St	6	2	39 July 17	66	74	39	56	--	56
Midchannel Dyckman St	6	2	39 July 17	67	77	39	58	--	58
Midstream Spuyten D.	6	2	36 July 17	67	71	36	53	--	53
Harlem River									
Midstream-106 St	8	2	5 July 16	53	13	5	--	--	9
Midstr. Willis Ave.	8	2	2 July 16	57	5	2	--	--	3
Midstr. 151 St	8	2	47 July 16	64	53	47	--	--	50
Midstr. Morris Hts.	8	2	4 July 17	57	11	4	7	--	7
Midstr. Spuyten D.	8	2	44 July 17	68	44	49	47	--	47
Upper Bay									
Robbins Reef Bell B.	4	2	53 July 17	67	53	63	--	58	58
Bell Buoy 2 G.	4	2	53 July 17	57	52	52			53
The Narrows									
Off Ft. Lafayette	2	2	60 July 17	63	60	66	--	63	63
Midstream	2	2	64 July 17	68	64	71	--	68	68
Off Ft. Wadsworth	3	2	66 July 17	73	66	75	77	71	73

Complainants Exhibit No 231
Sheet 8.

SUMMARY OF DISSOLVED OXYGEN RESULTS — Acc 2566

WATERS AROUND NEW YORK 1918 — Computer W.T.C. — From — to

Made in connection with ROUTINE STUDIES — Checker — Date April 29, 1919.

MISCELLANEOUS STATIONS

SAMPLING POINT	TOTAL NUMBER of SAMPLES	PERCENT SATURATION MINIMUM and DATE	AVERAGE FOR YEAR	AVERAGE FOR Period July 16 17 18
Upper Bay				
Mouth of Gowanus Bay	4	52 July 17	61	55
Newton Creek and Branches				
English Kills at Johnson Av.	1	0 Jan 25		
South of Maspeth Av.	1	0 Jan 25		
Meeker Av.	1	10 Jan 25		
Greenpoint Av.	1	18 Jan 25		
Brant St.	1	25 Jan 25		
Union Ave. Bridge	1	31 Jan 25		
Kill van Kull				
Opp B & O Coal Dock	4	48 July 18	59	51
At Shooters I'd Ferry	4	53 July 18	61	55
Arthur Kill				
At B & O. R.R. Bridge	4	51 July 18	58	52
Opp So. Fork of Fresh Kills	2	48 July 18	56	56
Opp Tottenville F'y Slip	2	70 July 18	75	75
East River East of Hell Gate				
Betw. Lawrence & Stony P'ts	4	38 July 16	55	39
Betw. Baretto Point & Riker I'd	4	38 July 16	56	40
Off F'y Slip Mouth Flush. Bay	4	39 July 16	63	51
200' N. of B'w'y Bridge Flush C'k.	4	23 July 16	51	27
Betw. Closson P't & Tallman I'd.	4	52 July 16	68	55
Betw. Old F'y P't & Whitest. P't.	2	54 July 16	56	56
Betw. P'ts Schuyler & Totten	4	58 July 16	71	59
Hudson River				
Midstr W. 42d St.	6	49 July 17	71	62

Complainants Exhibit No 231
Sheet 9.

New York & New Jersey
Complaints by 231
James J. Mahon
Commissioner
Sheet 10
MAP OF NEW YORK HARBOR
SHOWING
PERCENTAGE SATURATION OF
DISSOLVED OXYGEN
1916
Large figures are averages of samples taken on ebb and flood currents
Small figures are numbers of Samples taken on ebb and flood currents
Arrows show direction of current when samples were taken
SCALE OF MILES
YONKERS
WEST VINCENT
BRONX
LONG ISLAND SOUND
NEW JERSEY
MANHATTAN
QUEENS
HOBOKEN
JERSEY CITY
NEWARK
WALLABOUT BASIN
BROOKLYN
UPPER BAY
NEWARK BAY
BAYONNE
ELIZABETH
KILL VAN KULL
THE NARROWS
GRAVESEND BAY
CONEY ISLAND
JAMAICA
ROCKAWAY BEACH
LAND

PLATE I

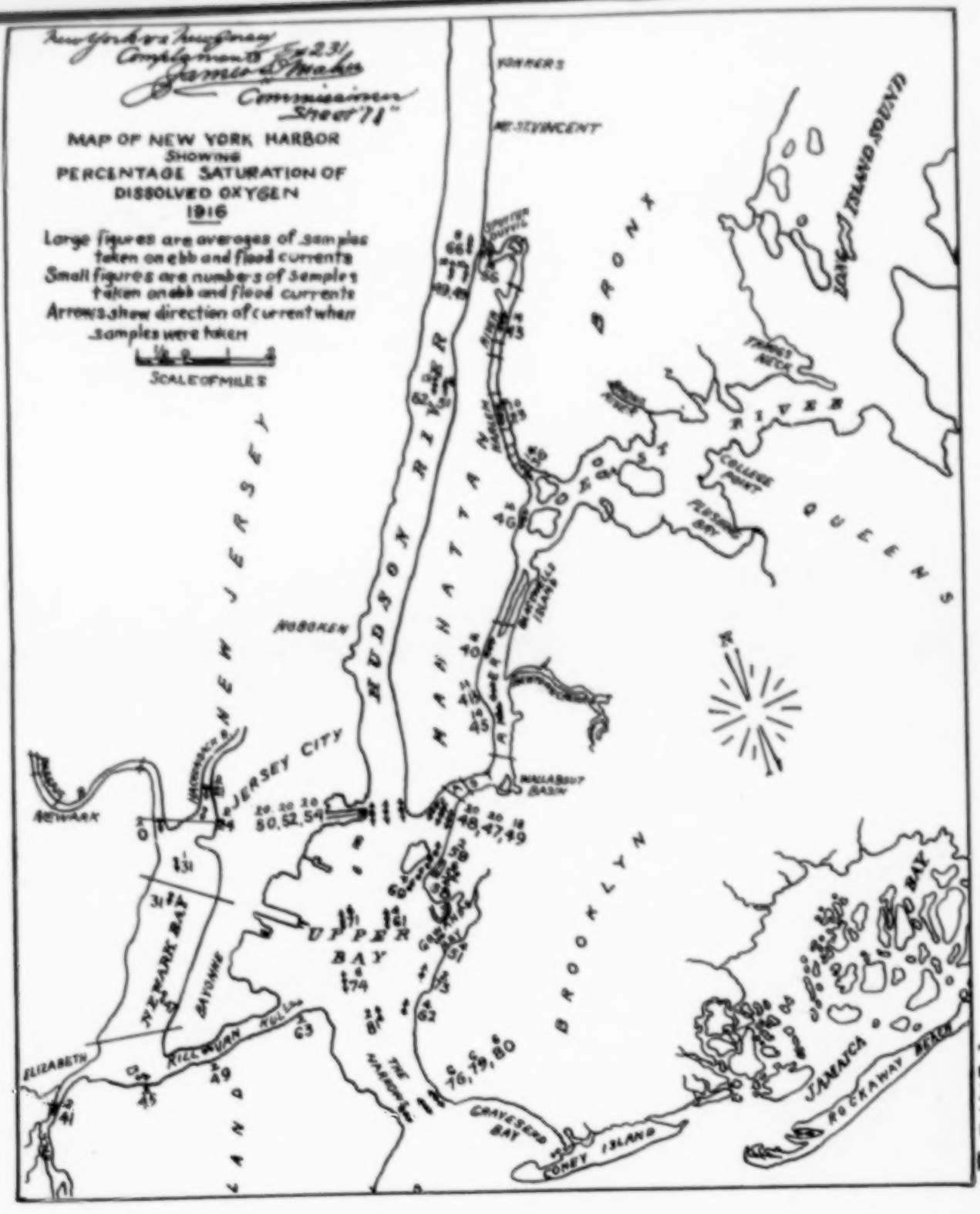

New York vs New Jersey
Complaints Ex 231
James D. Maher
Commissioner
Sheet "71"
MAP OF NEW YORK HARBOR
SHOWING
PERCENTAGE SATURATION OF
DISSOLVED OXYGEN
1916
Large figures are averages of samples taken on ebb and flood currents
Small figures are numbers of samples taken on ebb and flood currents
Arrows show direction of current when samples were taken
SCALE OF MILES
YONKERS
MT. ST. VINCENT
BRONX
LONG ISLAND SOUND
TRAVERS NECK
COLLEGE POINT
FLUSHING BAY
QUEENS
NEW JERSEY
HUDSON RIVER
MANHATTAN
HOBOKEN
JERSEY CITY
NEWARK
WALLABOUT BASIN
UPPER BAY
NEWARK BAY
BAYONNE
KILL VAN KULL
ELIZABETH
THE NARROWS
GRAVESEND BAY
CONEY ISLAND
BROOKLYN
JAMAICA BAY
ROCKAWAY BEACH
50, 52, 54
48, 47, 49
76, 79, 80

PLATE II

New York vs New Jersey
Complainants Ex 231
James D Mahey
Commissioner
Sheet "12"

MAP OF NEW YORK HARBOR
SHOWING
PERCENTAGE SATURATION OF
DISSOLVED OXYGEN
1916

Large figures are averages of samples taken on ebb and flood currents
Small figures are numbers of samples taken on ebb and flood currents
Arrows show direction of current wher samples were taken

½ 0 1 2
SCALE OF MILES

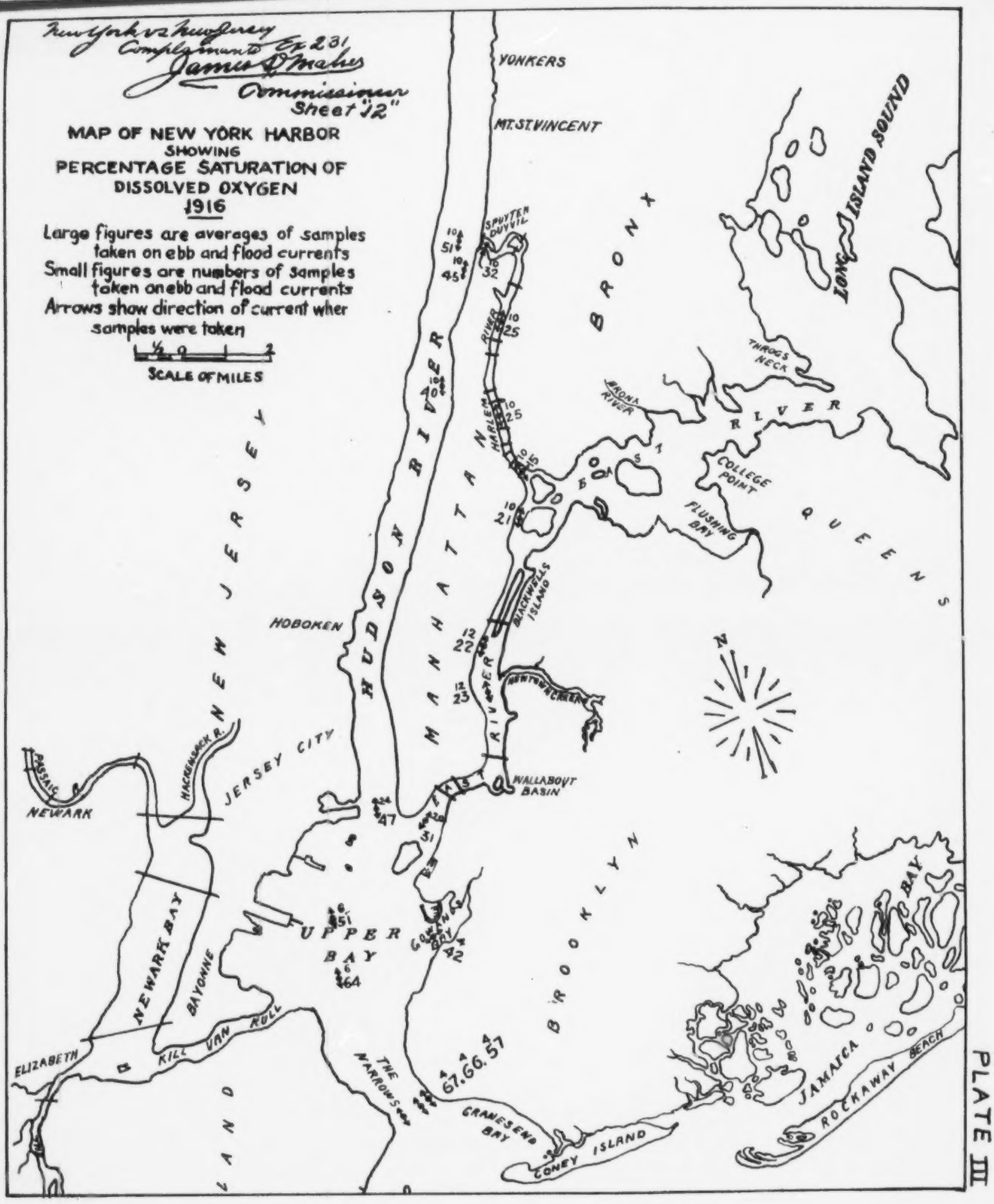


PLATE III

New York vs New Jersey
Complainants Ex 231
Commissioner
Sheet "13"

MAP OF NEW YORK HARBOR
SHOWING
PERCENTAGE SATURATION OF
DISSOLVED OXYGEN
1916

Large figures are averages of samples taken on ebb and flood currents
Small figures are numbers of samples taken on ebb and flood currents
Arrows show direction of current when samples were taken

SCALE OF MILES

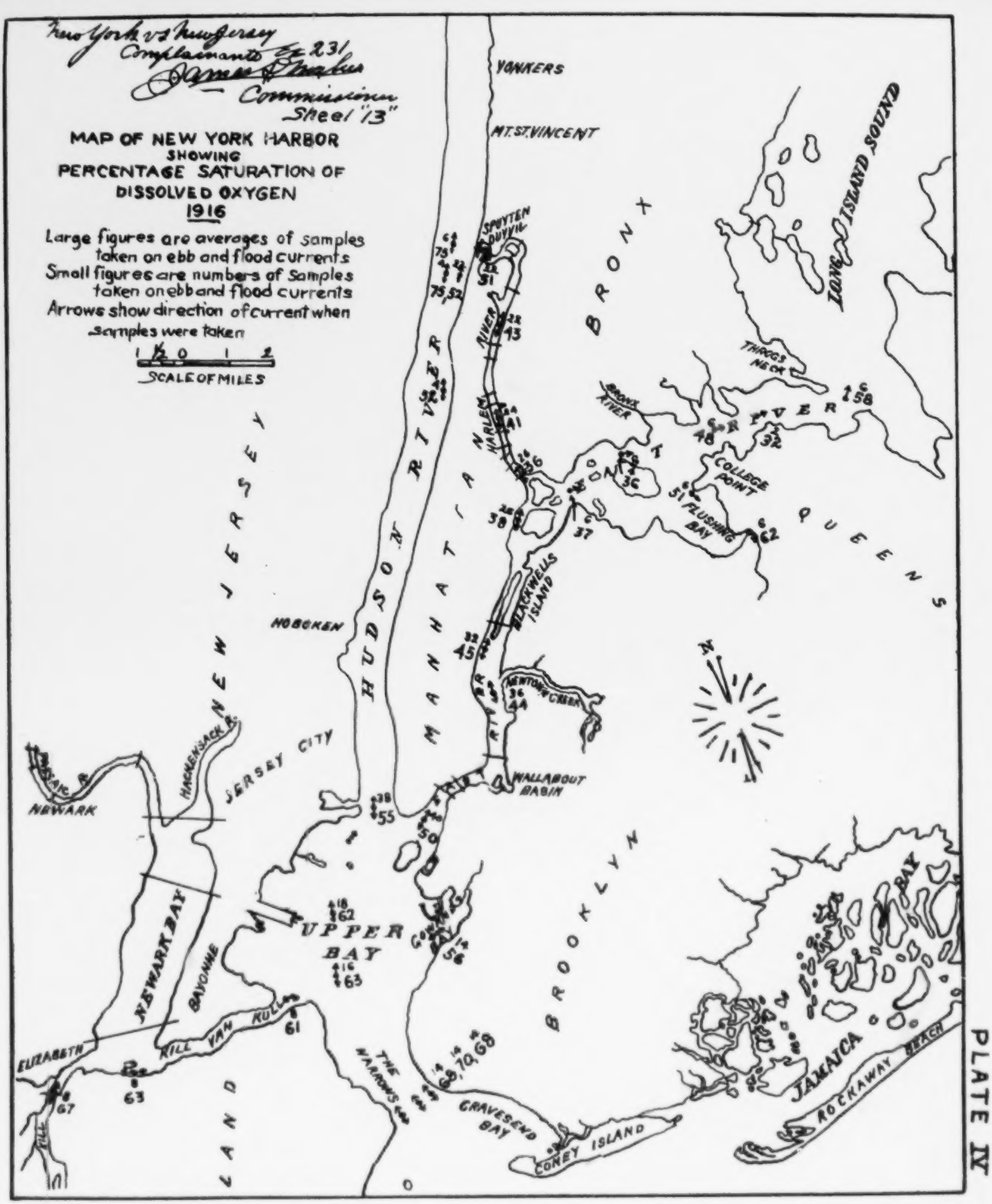
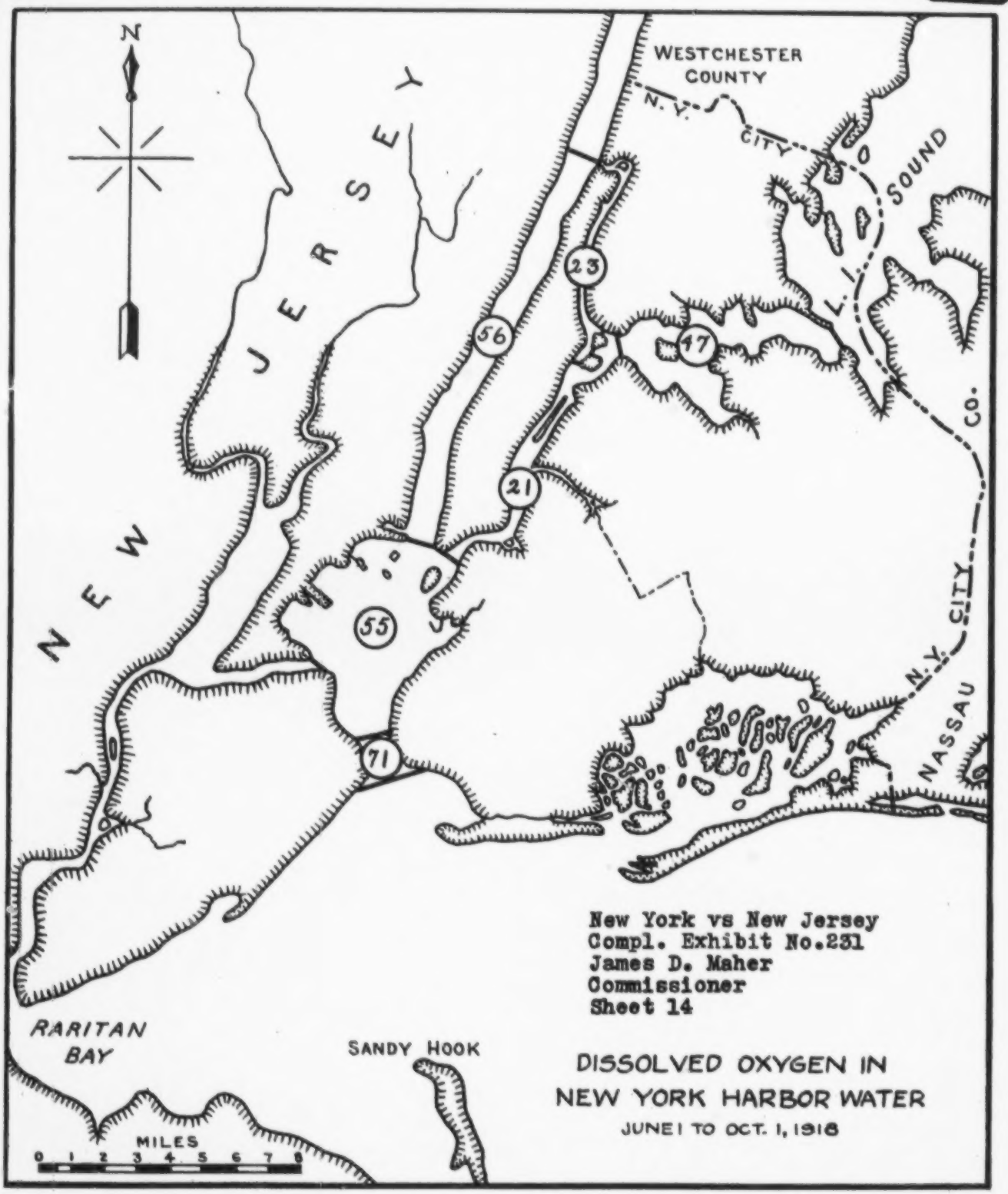


PLATE IV

ACC 4078 - FILE 3 C 321

PLATE 14



ACC. 2072 - FILE C321

Fig. 4

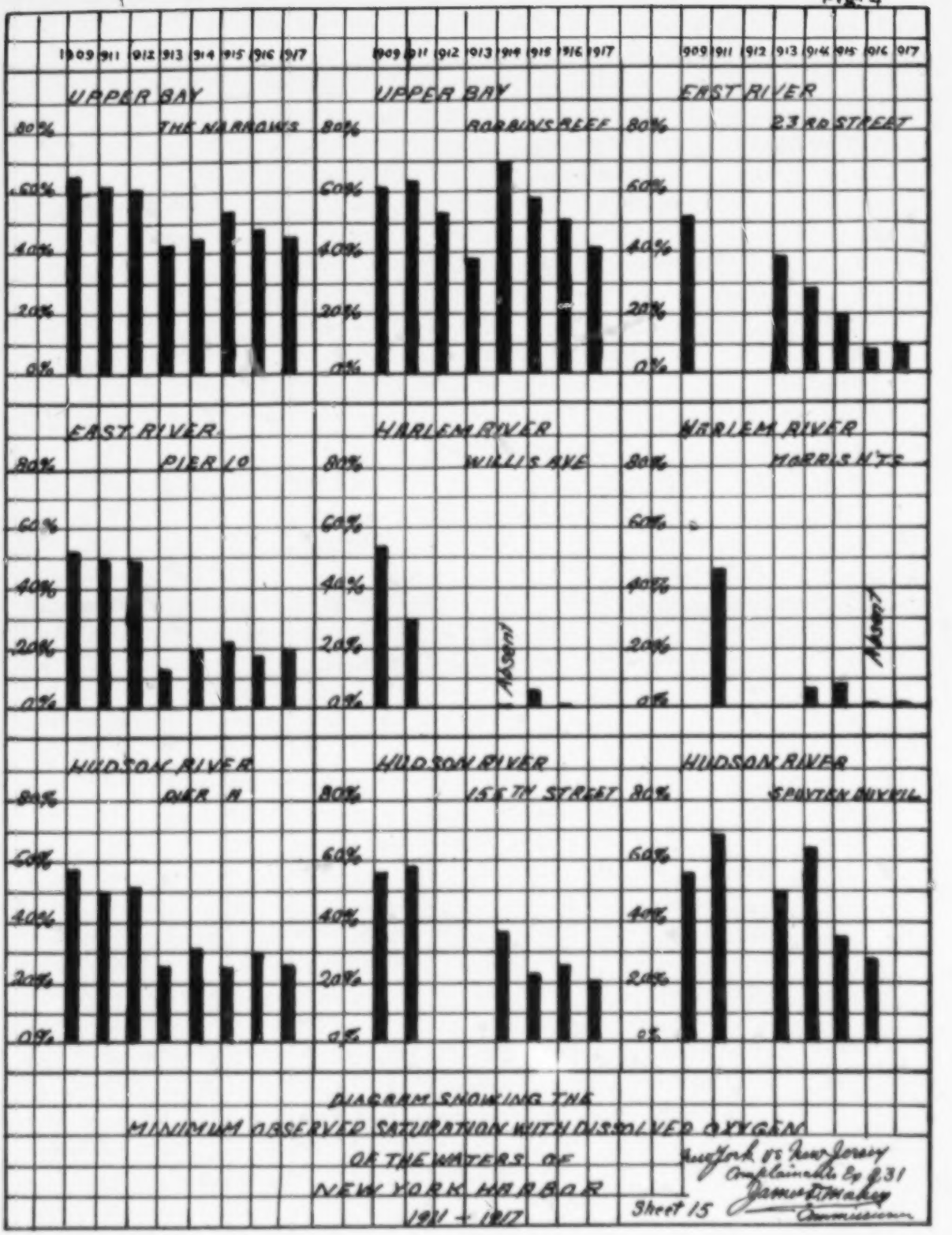
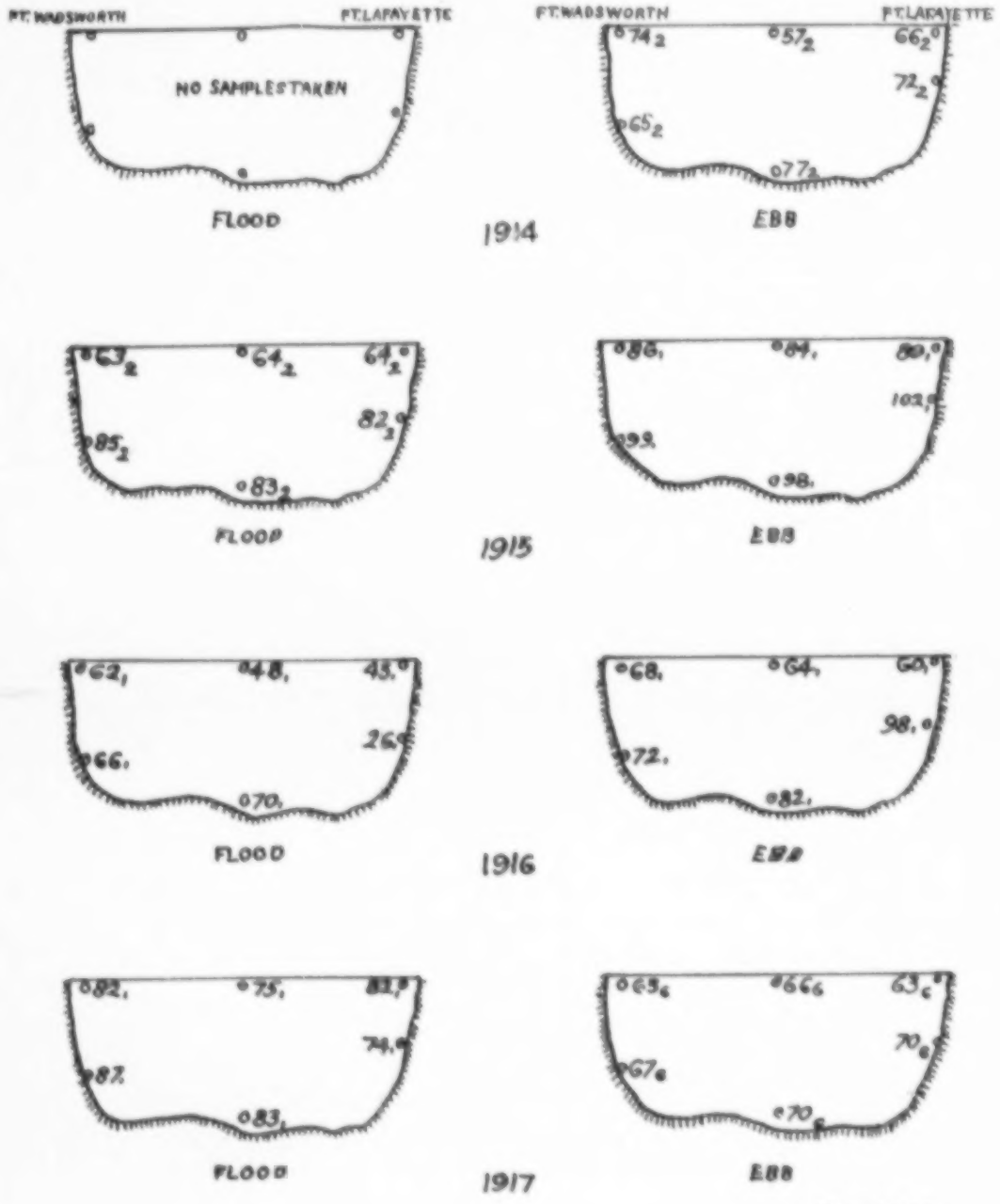


DIAGRAM SHOWING THE
MINIMUM OBSERVED SATURATION WITH DISSOLVED OXYGEN
OF THE WATERS OF
NEW YORK HARBOR
1911 - 1917

New York vs New Jersey
Complainants Ex. 231
James T. Whaley
Commissioner

Sheet 15



Sheet 16

New York vs New Jersey
Complainants Ex 231
James D Maher
Commissioner

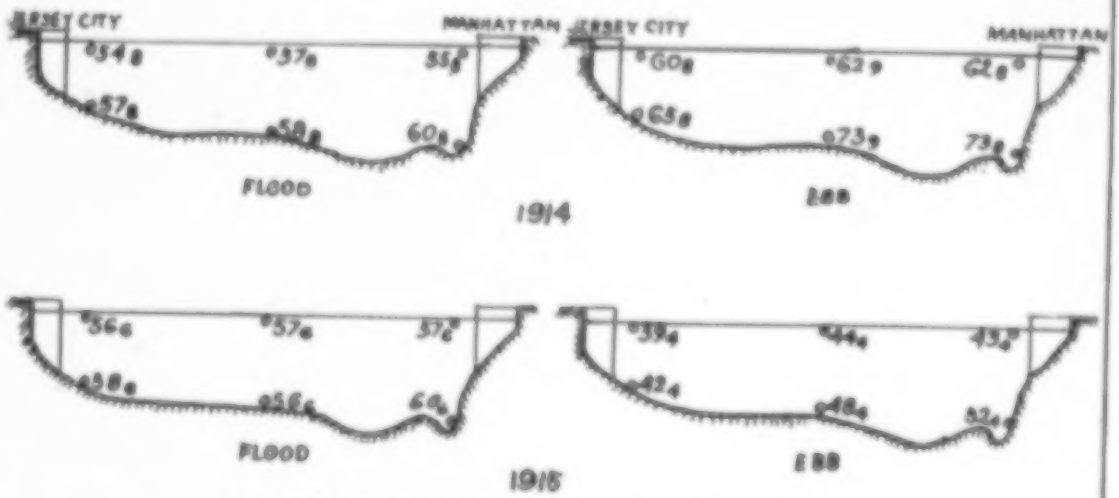
AVERAGE PERCENTAGE
OF
DISSOLVED OXYGEN
CROSS SECTION AT THE NARROWS

0 50' 100'
VERTICAL SCALE

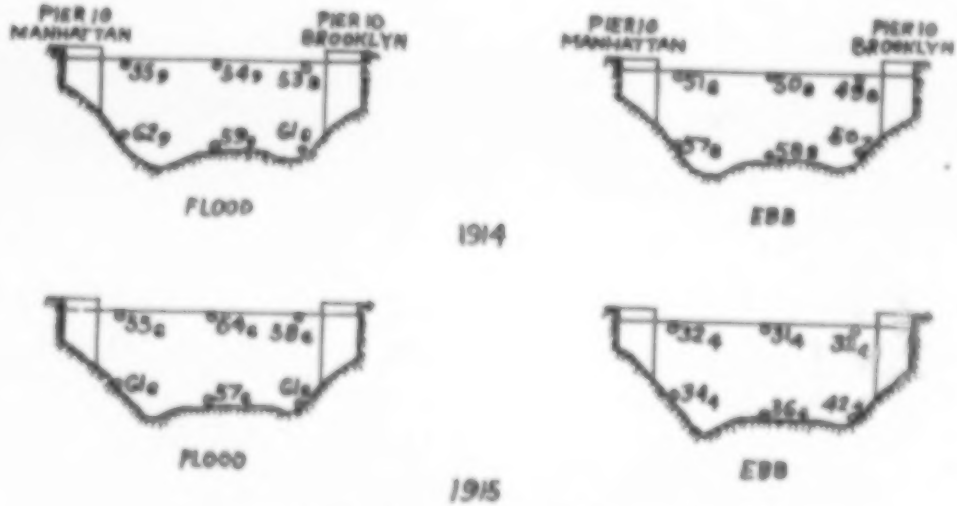
o Indicates sampling point
Percentage saturation shown by large figures
Number of samples taken " " small "

0 1000' 2000'
HORIZONTAL SCALE

ACC. 2072 - FILE 3.6321



CROSS SECTION OF HUDSON RIVER
FROM PIER A, MANHATTAN, TO C.R.R. of N.J. TERMINAL, JERSEY CITY



CROSS SECTION OF EAST RIVER
FROM PIER 10, MANHATTAN TO PIER 10, BROOKLYN

AVERAGE PERCENTAGE
OF
DISSOLVED OXYGEN
CROSS SECTION AT MOUTH OF
HUDSON AND EAST RIVERS

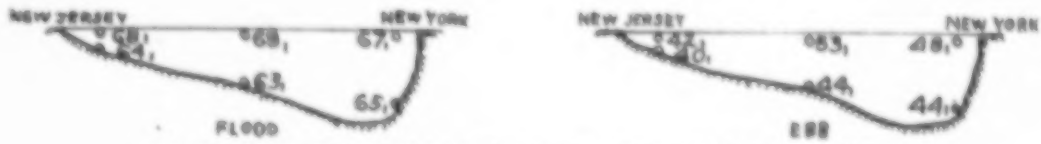
Sheet 17
New York or New Jersey
Complainant's Ex 231
James D. Maher
Commissioner

0 50' 100'
VERTICAL SCALE

o Indicates Sampling point
Percentage saturation shown by large figures
Number of Samples taken " " Small "

0 500' 1000' 2000'
HORIZONTAL SCALE

Acc. 2073 - FILE 3.632



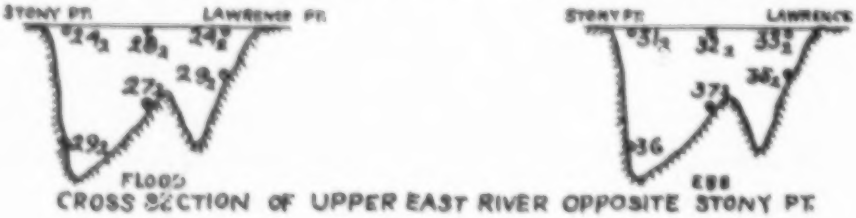
CROSS SECTION OF HUDSON RIVER OPPOSITE MT. ST. VINCENT

CROSS SECTION OF HUDSON RIVER OPPOSITE DYCKMAN ST.

CROSS SECTION OF HUDSON RIVER OPPOSITE 156TH STREET

CROSS SECTION OF UPPER EAST RIVER OPPOSITE THROGS NECK

CROSS SECTION OF UPPER EAST RIVER OPPOSITE CLASSON PT.



CROSS SECTION OF UPPER EAST RIVER OPPOSITE STONY PT.

AVERAGE PERCENTAGE OF DISSOLVED OXYGEN AT SELECTED CROSS SECTIONS 1914

Sheet 18
New York & Newfoundland
Complainant's Ex. 231
James P. Mahon
Examiner

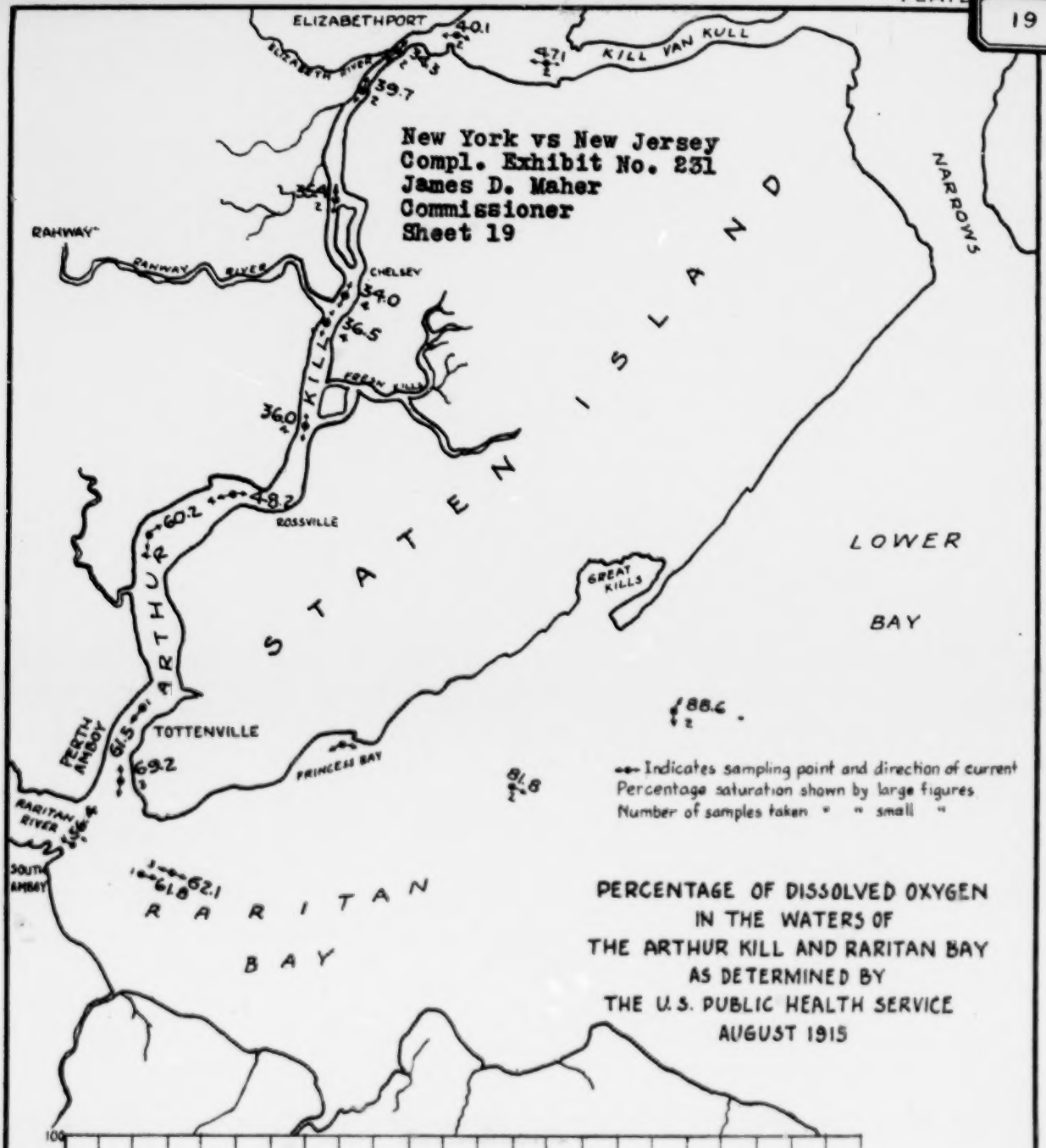
0 50' 100'
VERTICAL SCALE

0 Indicates sampling point
Percentage saturation shown by large figures
Number of samples taken " " small "

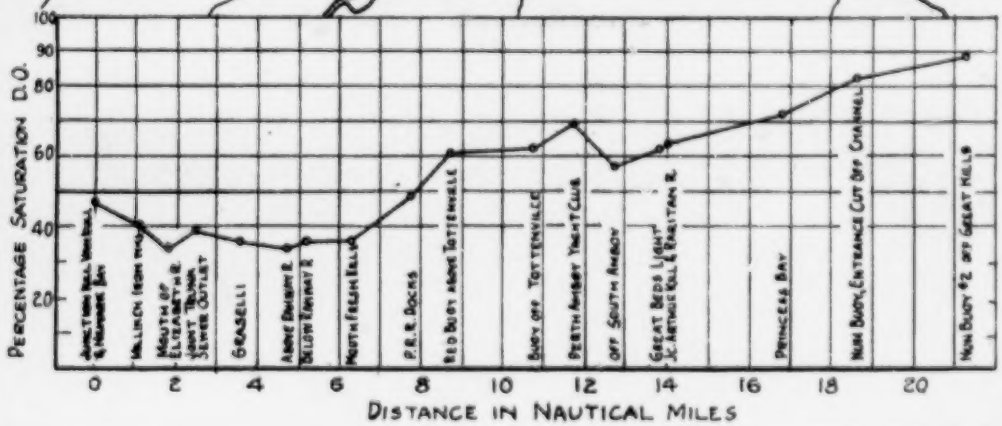
0 1000' 2000' 3000'
HORIZONTAL SCALE

PLATE 19

New York vs New Jersey
Compl. Exhibit No. 231
James D. Maher
Commissioner
Sheet 19



PERCENTAGE OF DISSOLVED OXYGEN
IN THE WATERS OF
THE ARTHUR KILL AND RARITAN BAY
AS DETERMINED BY
THE U.S. PUBLIC HEALTH SERVICE
AUGUST 1915



By Dr. O'Sullivan:

Q. Did you cause to be visualized the dissolved oxygen found in various parts of the harbor showing the depletion and the decrease between 1909 and 1917?

A. I did. This diagram shows the important parts of the harbor. There is a diagram for each location, each body of the harbor. For instance——

Mr. Riker: I object to his testifying from this document, until it is offered and proved.

Dr. O'Sullivan: I offer the visualized graphic outlines described by this witness, showing the dissolved oxygen in the various parts of New York Harbor, and its depletion from 1909 to 1917, in evidence, and ask that it be marked Complainants' Exhibit No. 232.

By Mr. Riker:

Q. Who prepared this chart, Mr. Allen?

A. I did.

Q. Personally?

A. Part of it, yes.

711 Q. What part of it did you personally prepare?

A. The chart was made originally by the Metropolitan Sewerage Commission, and I think that was to 1913. I took the original tracing, and I changed the lines on it and the marking so that it would be correct to 1917.

Q. Had you verified the matter that you took as the basis of your alterations?

A. That is printed in the report of the Metropolitan Commission.

Q. I ask you whether you had verified it in any way?

A. I had no means of verifying it.

Q. You simply have accepted it, have you?

A. It would be impossible to verify it.

Q. I ask you if you simply accepted it as correct?

A. Yes.

Q. Now the matter which you put on here to illustrate graphically some results, where did you get that from?

A. I thought I answered that question. From the Metropolitan Sewerage Commission's Report, and then the recent, the 1917, results from these tables I have just handed to you.

Q. This is, then, a graphic illustration of the contents of the tables which have been offered in evidence and objected to, is that it?

A. The diagrams are made up from two series of observations. The first series of 1909 was made by the Metropolitan Sewerage Commission, and published in their report. The second series of 1917 was given in the exhibit already submitted.

712 Q. As to the report of 1909, you have no knowledge of your own in regard to its truth or falsity?

A. No.

Q. As to the additional matter from 1909 to 1917, you got that from these last two exhibits which have been offered, objected to and marked as exhibits, as to which you have testified that you did not make any of these determinations?

A. Yes.

Mr. Riker: The offer is objected to on the ground that, on the admissions of the witness, it contains no matter of which he has personal knowledge; and it is therefore not sufficiently proved to be admitted in evidence; it is hearsay, irrelevant and immaterial.

The Commissioner: Note the objection of counsel for the defendants.

(The paper was marked Complainants' Exhibit No. 232.)

(Here follows diagram marked page 712a.)

By Dr. O'Sullivan:

Q. You were with the Metropolitan Sewerage Commission when these determinations, the first ones, were made, were you not?

A. Yes.

Q. Did you prepare any other charts or diagrams expressive of the percentage saturation of dissolved oxygen in the harbor waters between 1909 and 1918?

A. I did. This series of charts is intended to show the average amount of dissolved oxygen in the harbor at different selected points from month to month. In some cases, no observations were
713 made in the winter months, and in those cases the curve can be considered only roughly approximate.

Q. Did you prepare these curves?

A. They were prepared under my direction.

Dr. O'Sullivan: I offer the three sheets showing the curves, the oxygen percentage saturation of dissolved oxygen at the various points indicated in the charts themselves, in evidence, and ask that they be marked as Complainants' Exhibit No. 233.

By Mr. Riker:

Q. Does this offer as an exhibit, contain anything in substance that was not contained in the last offer?

A. All these curves are based on figures which are found in those two reports.

Q. This is a graphic delineation by curves of the same matter that is contained in the tables?

A. In the tables, and in the tables given by the Metropolitan Sewerage Commission.

Q. That goes back prior to 1909, you have testified to that as in the other case?

A. Yes.

Q. This offer as an exhibit also contains further matter of estimated condition during months when no actual observation is even alleged to have been made?

A. Yes, sir.

Q. And it is as to those months a guess as to the condition?

A. Yes.

Mr. Riker: The offer is objected to on the same ground
714 as the last offer was objected to.

The Commissioner: Note the objection of counsel for the defendants.

By Dr. O'Sullivan:

Q. When you used the expression "guess," Mr. Allen, what did you wish to imply?

A. I wished to imply that it was a well-considered estimate based on collateral evidence.

Q. Does that collateral evidence, as you describe it, include pr
oxygen determinations?
A. Yes.

(The paper was marked Complainants' Exhibit No. 233.)

(Here follows diagram marked page 714a.)

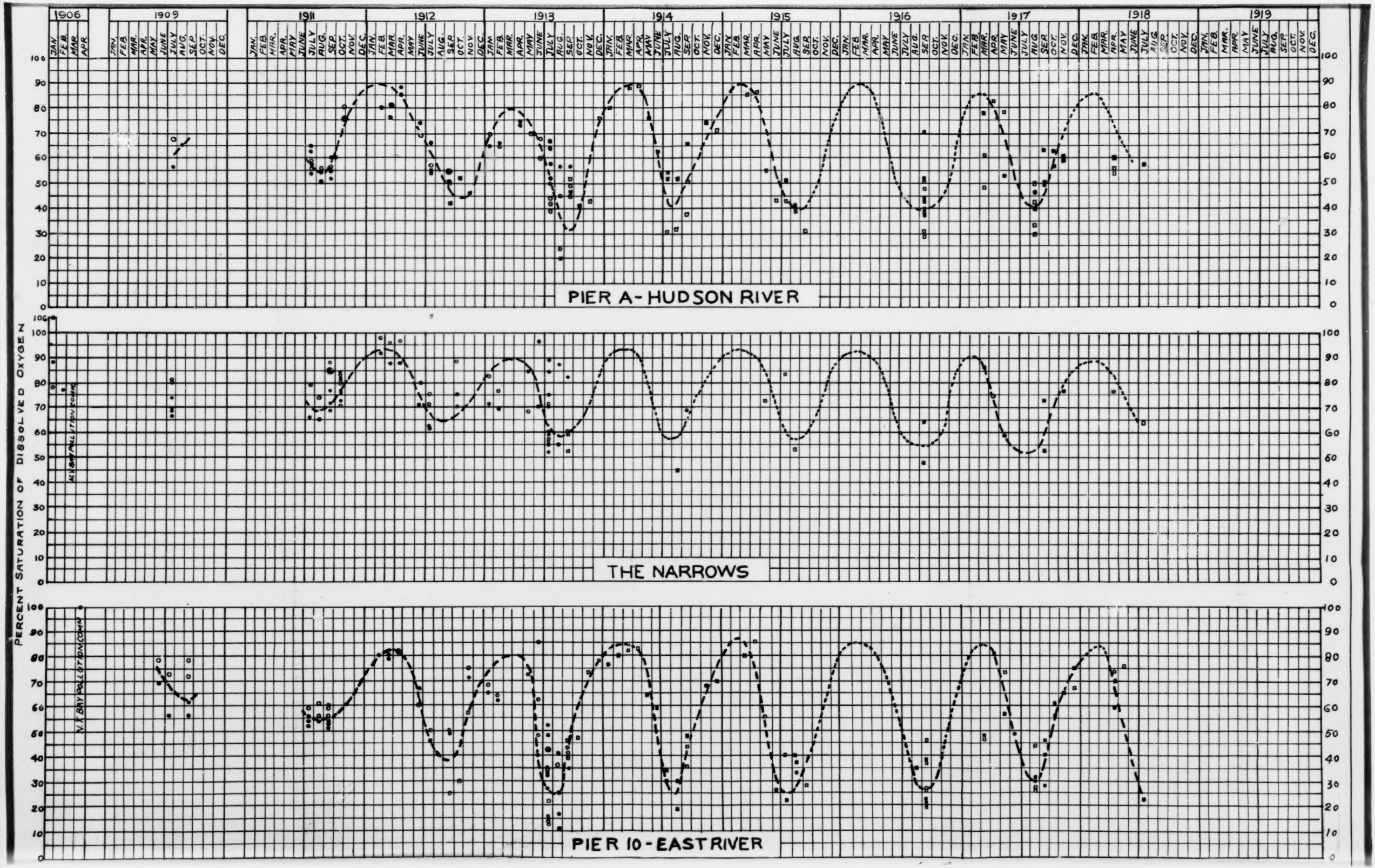
PERCENT SATURATION OF DISSOLVED OXYGEN

1909 1911 1912 1913 1914 1915 1916 1917 1918 1919

106TH ST. - HARLEM RIVER

WILLIS AVE BRIDGE - HARLEM RIVER

MORRIS HEIGHTS - HARLEM RIVER



1906
1909
1911
1912
1913
1914
1915
1916
1917
1918
1919
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEP. OCT. NOV. DEC.
PIER A - HUDSON RIVER
THE NARROWS
PIER 10 - EAST RIVER
PERCENT SATURATION OF DISSOLVED OXYGEN
N.Y. BAY POLLUTION COMM.

PERCENT SATURATION OF DISSOLVED OXYGEN

1909 1911 1912 913 1914 1915 1916 1917 1918 1919

JAN. FEB. MAR. APR. MAY. JUNE JULY AUG. SEP. OCT. NOV DEC.

100 90 80 70 60 50 40 30 20 10 0

SPUYTEN DUYVIL – HARLEM RIVER

B= BOTTOM SAMPLE

23RD STREET – EAST RIVER

42ND STREET – EAST RIVER

Q. In determining the percentage saturation of oxygen according to the seasons and according to the percentages of land and salt water, what standard did you take, Mr. Allen?

A. I took as a standard the table prepared by the Royal Commission of Sewage Disposal, and printed in their 5th Report, Appendix 6; and from that a diagram was prepared by the Metropolitan Sewerage Commission, which shows the percentage of saturation, or rather, the cubic centimeters per liter of oxygen which sea water will hold when saturated, and which land water will hold when saturated, and which intermediate proportions will hold, and at different temperatures. For instance, at a temperature of 60 degrees Fahrenheit the distilled water will hold 7.1 cubic centimeters per liter; while sea water will only hold 5¾ cubic centimeters
715 per liter.

Dr. O'Sullivan: I offer in evidence the standard used by the Board of Estimate and Apportionment and by the Metropolitan Sewerage Commission for determining the saturation of tidal waters containing various percentages of sea water and the standard used by both the Metropolitan Sewerage Commission and the Board of Estimate and Apportionment, in the determinations hitherto made, and ask that it be marked Complainants' Exhibit No. 234.

By Mr. Riker:

Q. Mr. Allen, what did you do in the preparation of this paper?
A. Nothing.
Q. You had nothing to do with it?
A. No, sir.
Q. Where did it come from?
A. Originally from the office of the Metropolitan Sewerage Commission.
Q. Who prepared it?
A. I do not remember who prepared it.
Q. Have you verified it in any way?
A. I have.
Q. In what way?
A. By referring to the original report of the Royal Sewerage Commission.
Q. When did you do that?
A. A few days ago.
Q. In what way did you verify it?
A. It is given there in the form of a table, and I verified the figures given of the curve, by the figures given in the table.

Q. Then the figures given as percentages of volume of
716 oxygen at 32 Fahrenheit, correspond, as you find, with the report of this Royal Society?

A. Yes; Royal Commission of Sewage Disposal.
Q. That is all you know about it?
A. Yes.
Q. You have not made any determination of percentages?
A. No.

Q. You do not know whether they are correct or not?
A. Not at all.

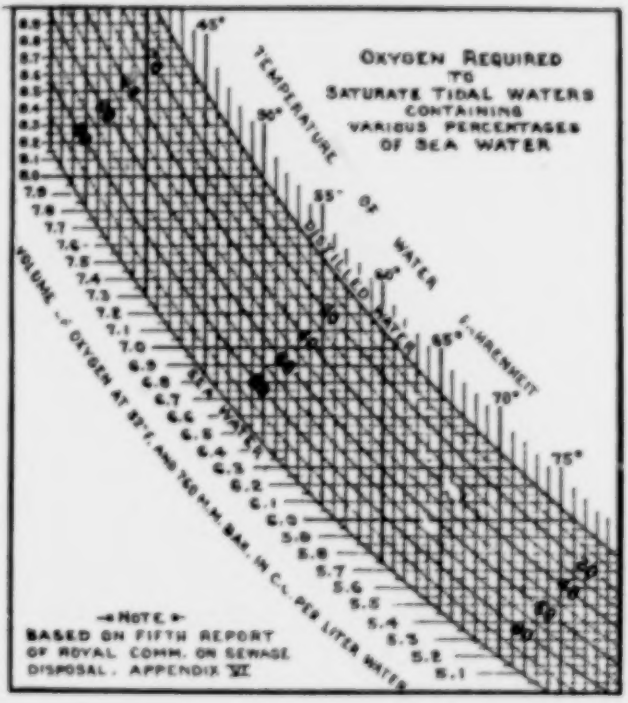
Mr. Riker: The offer is objected to on the same ground as the la
offer.

The Commissioner: Note the objection of counsel for the defen
ants.

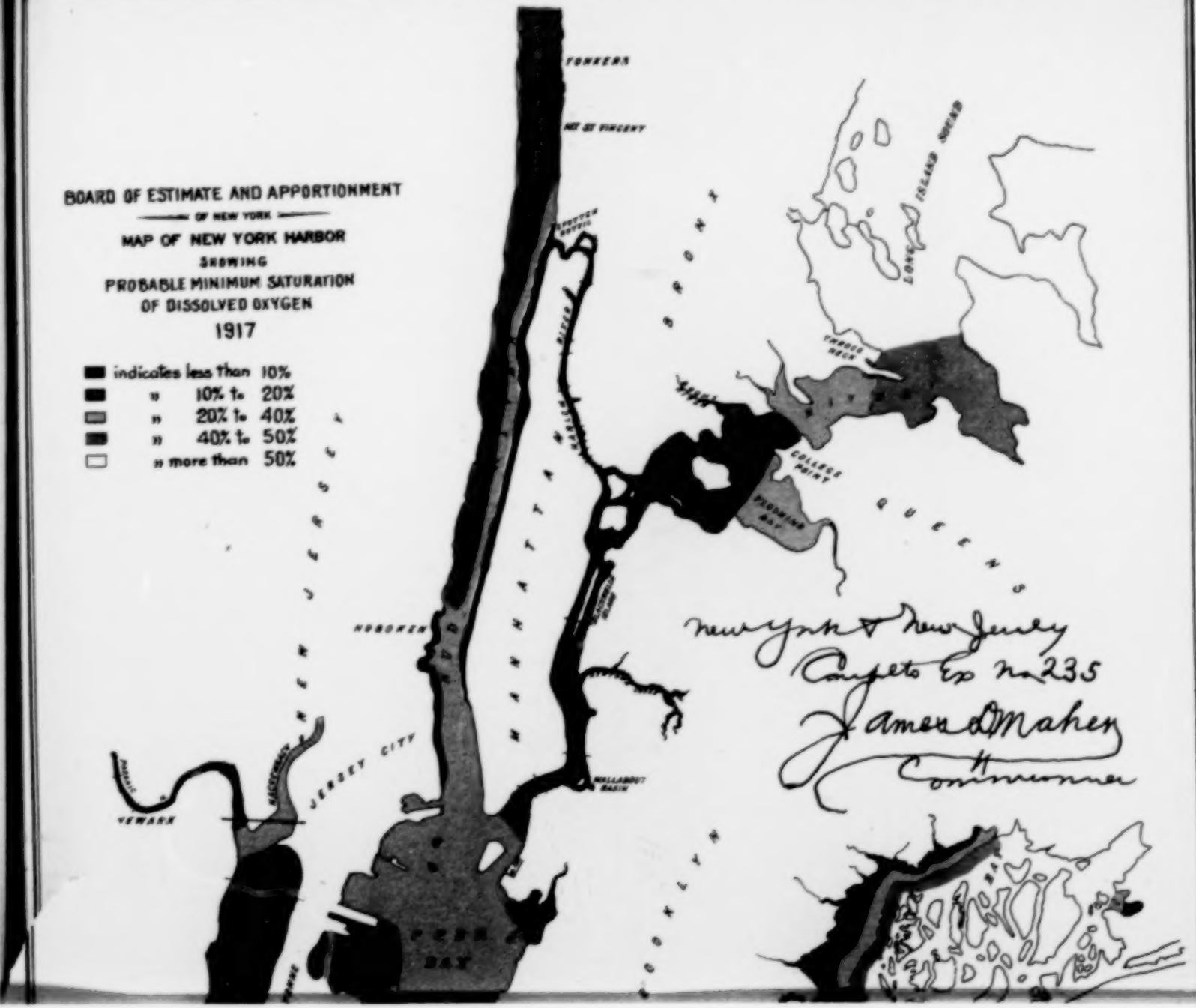
(The paper was marked Complainants' Exhibit No. 234.)

(Here follows diagram marked page 716*a*.)

(19)



New York v New Jersey
Complaints Ex 234
James D Maher
Commissioner


BOARD OF ESTIMATE AND APPORTIONMENT
OF NEW YORK
MAP OF NEW YORK HARBOR
SHOWING
PROBABLE MINIMUM SATURATION
OF DISSOLVED OXYGEN
1917
indicates less than 10%
" 10% to 20%
" 20% to 40%
" 40% to 50%
" more than 50%
TONKERS
MT ST VINCENT
BRONX
LONG ISLAND SOUND
THROGS NECK
COLLEGE POINT
FLUSHING BAY
QUEENS
NEW JERSEY
HOBOKEN
MANHATTAN
JERSEY CITY
NEWARK
WALLABOUT BASIN
BROOKLYN
PORT BAY
New York & New Jersey
Complete Ex No 235
James D Maher
Commissioner

more than 50%
HOBOKEN
JERSEY CITY
NEWARK
STATEN ISLAND
LOWER NEW YORK BAY
ATLANTIC OCEAN
RARITAN BAY
New York & New Jersey
Complete Ex No 235
James D Maher
Commissioner

By Dr. O'Sullivan:

Q. As Sanitary Engineer of the Board of Estimate and Apportionment, Mr. Allen, did you cause to be visualized upon a map of New York Harbor waters, the area showing the minimum saturation of dissolved oxygen for 1917?

A. I did.

Q. Have you that map?

A. Yes (producing map).

Dr. O'Sullivan: I offer this map in evidence, and ask that it be marked Complainants' Exhibit No. 235.

By Mr. Riker:

Q. Where did you get the oxygen determinations of waters in New York Harbor for the year 1917?

A. From the determinations which have been submitted.

717 Q. That is, you got them from these tables which you have testified to you had nothing to do with?

A. Yes.

Q. And don't know whether they are correct or not?

A. Not from personal observation.

Q. This is then, a further graphic delineation of matters which are included in the Report for the year 1917, but as to which you have done no personal work?

A. In connection with the analyses?

Q. Yes.

A. That is right.

Q. And with the taking of the samples?

A. No personal work.

Q. Or in any other part of the actual determination of the dissolved oxygen?

A. No.

Q. You have merely assumed that the figures that you had received for 1917, are correct, and you have put graphically the result of those figures on this map which is now offered in evidence?

A. Yes.

Mr. Riker: The offer is objected to on the same ground as the last offer.

The Commissioner: Note the objection of counsel for the defendants.

(The paper was marked Complainants' Exhibit No. 235.)

(Here follows map marked page 717a.)

By Dr. O'Sullivan:

Q. In answer to a question put to you by Mr. Riker, Mr. Allen, you said you had nothing to do with the oxygen determi-
718 nations. I ask you, what did you have to do with the oxygen determinations?

A. I directed the sampling of the water by the party that made the examinations. I told them where the several samples were to be taken and when, and the results were reported to me.

Q. Reported by whom?

A. By the analyst.

Q. The chemist?

A. The chemist.

By Mr. Riker:

Q. Do you know whether your instructions were obeyed?

A. I was not on the spot.

Q. I ask you again, do you know whether your instructions were obeyed?

A. I have no reason to think they were not.

Q. I ask you once more, do you know whether your instructions were obeyed?

A. No, I could not say positively.

By Dr. O'Sullivan:

Q. In the reports made to you by the chemist who made the oxygen determinations, and who was working under your supervision as you have described, what were the oxygen determinations that he reported to you for the different points in the harbor?

Mr. Riker: The question is objected to on the ground that it is hearsay, irrelevant and immaterial.

The Commissioner: Note the objection of counsel for the defendants.

A. The result in 1909 in Newark Bay varied from 76 to
719 78 per cent.

Robbins Reef, 68 to 71 per cent; at the Narrows, it averaged 83 per cent.

In 1911, the average was 63 per cent in Newark Bay; 73 per cent Robbins Reef; 78 per cent at the Narrows.

1912, there were none in Newark Bay; 75 per cent at Robbins Reef; 81 per cent at the Narrows.

1913, none at Newark Bay; 70 per cent at Robbins Reef; 73 per cent at the Narrows.

1914, none at Newark Bay; 71 per cent at Robbins Reef; 67 per cent at the Narrows.

1915, 31 to 47 in Newark Bay; 72 per cent at Robbins Reef; 79 per cent at the Narrows.

1916, none at Newark Bay; 64 per cent at Robbins Reef; 66 per cent at the Narrows.

1917, none at Newark Bay; 50 per cent at Robbins Reef; 63 per cent at the Narrows.

1918, none in Newark Bay; 58 per cent at Robbins Reef;
720 68 per cent at the Narrows.

The question of the dissolved oxygen at Moon Island, Boston Harbor, was mentioned, and on September 7th, 1911, I visited the work and noted about 500 feet from the outlet at the time of discharge and in the sewage field, the specific gravity of the water at the surface was 1.024, and with 68 per cent of dissolved oxygen. At a depth of one foot, the dissolved oxygen was the same. At a depth of two feet, the specific gravity was reduced to 1.023. At the depth of three feet, it was 1.0235; and at the bottom, the dissolved oxygen was 100 per cent saturation—saturation to 100 per cent—showing that the pollution there under those conditions kept on the surface and did not readily diffuse through the body of the water.

Then, in connection with the standard of dissolved oxygen, I have made here a little compilation of different authorities, of all harbor waters——

Mr. Riker: Is this in answer to any inquiry?

Dr. O'Sullivan: Yes; I have made the general inquiry. This man has been given the duty to relieve very acute conditions in New York City from its sewage pollution, and to show whether or not the harbor waters can bear the added burden from the Passaic Valley Trunk Sewer; and he has taken all the standards that he
721 could possibly avail himself of from other locations; and the ones he is now dealing with are particularly embodied in the testimony here by Mr. Stearne, by Mr. Fuller and by Mr. Whipple.

Mr. Riker: I wish the stenographer would read the question to which these statements by this witness purport to apply.

(Question repeated by the stenographer as follows:

"Q. In the reports made to you by the chemist who made the oxygen determinations, and who was working under your supervision as you have described, what were the oxygen determinations that he repirted to you for the different points in the harbor?")

Mr. Riker: I move to strike out the testimony of this witness as to all matters including and subsequent to the testimony as to the Moon Island and Boston conditions as being irrelevant, immaterial, and not within the scope of the inquiry authorized by the order of March 10th, 1919.

The Commissioner: Note the objection of counsel for the defendants.

Q. You may finish your answer.

A. These standards have been suggested as standards by different authorities:

Prof. Adeney recommends from 60 to 70 per cent saturation.

Mr. Fitzgerald, 50 per cent.

Prof. Winslow, 50 per cent.

722 Mr. Eddy, 3 cubic centimeters per liter, which under ordinary summer conditions, would be about 58 per cent; and

that was the recommendation of the Metropolitan Sewerage Commission also.

Mr. Hering recommends 25 per cent, provided the bottom is dredged and kept clean of deposits.

Dupres, the French authority, recommends from 25 to 30 per cent.

Kinnicutt, Winslow & Pratt, in their book, recommend 50 per cent.

George W. Fuller suggested half of that recommended by the Metropolitan Sewerage Commission, or 1.5 cubic centimeter per liter.

Messrs. Hill, Jackson & Horton, in preparing evidence for the original hearing in this case, found that odors developed when there was anywhere from 23 to 67 per cent saturation.

Prof. Phelps recommends 25 to 50 per cent, depending on conditions.

Prof. Whipple, 20 per cent.

Mr. Weston, from 40 to 70 per cent, depending on conditions.

Wisner & Pearse recommend, for winter conditions, 20 per cent, and for sumer conditions, 30 per cent.

723 And with reference to New York Harbor, in the report submitted, I have recommended from 30 to 50 per cent, depending upon conditions.

Mr. Riker: I move to strike out all this last testimony as being a mere restatement of what appears in the record, and not called for by any question of this witness, and as being immaterial and irrelevant at this stage of the inquiry.

The Commissioner: Note the motion of counsel for the defendants.

Q. Have you finished your answer?

Mr. Riker: You say "answer." I do not understand there is any question here. If I am mistaken, I wish you would keep me straight on that.

Dr. O'Sullivan: He has not finished his answer to my original question yet.

A. With regard to the oxygen in Newark Bay, that is kept at a higher saturation than would be expected on account of the sea water which enters through the Narrows in Kill Van Kull.

Q. Does that mean the large proportion of the tidal prism to the waters at low awter?

A. In other words, the proportion of tidal prism with relation to the volume below mean low water.

Q. How many sewer outlets are there from New York City?

724 A. Four hundred and fifty-five.

Q. Will you describe where they are.

A. In Manhattan there are 62 entering the Hudson River; 128 entering the East and Harlem Rivers, making 190. Of those entering the Hudson River, 31 have been extended to the pierhead. Of those entering the Harlem and the East River, 30 have been ex-

tended to the pierhead, making a total of 190, of which 61 are extended to the pierhead.

The Bronx has 30 all told.

Brooklyn has, entering the Newton Creek, 10. The East River, Upper Bay and Gravesend Bay, 78. Coney Island, 5. Jamaica Bay, 5. Making a total of 98.

The Borough of Queens, entering Newtown Creek and East River, has 58.

Jamaica Bay, 34.

Baking 92 altogether.

In Richmond there are 45, in addition to which there are three private sewers, which in all make 455 public sewers.

Q. Mr. Allen, have you made investigations to determine the ages of sewages, their staleness, septicity, and other factors that would be of an objectionable character in sewage; and if so, state what your investigations consisted of.

A. I have. I have inquired of various sewage engineers as to the conditions at their works, especially where there are sprin-
725 kling filters in operation. I have found the following results:

At Batavia, New York, the sewage travels on an average of about 2½ miles, and is considered stale when it reaches the plant. By stale, I mean sewage that is practically devoid of dissolved oxygen, and verging on the putrescible condition.

At Schenectady, the sewage reaches the plant when it is about five hours old, with an extreme travel of six miles, average travel of 4½ miles, and is stale when it reaches the plant.

At Atlanta, Georgia, the age is 4½ hours, the extreme travel is 5 miles, the average travel is 4½ miles. That is stale when it reaches the works.

At Baltimore, it is five hours old, and the average travel is about 8 miles, and there it is septic when it reaches the works.

At Columbus, Ohio, there is an extreme travel of about ten miles, average travel of about 4 miles, and that is septic when it reaches the works.

At Cleveland they report the age as six to eight hours, and the average distance of travel 5 miles, and the condition as stale on reaching the works.

My conclusion has been that in warm weather this condition of verging on septicity is reached with a flow of six or eight
726 miles under ordinary conditions.

Q. Have you yourself, Mr. Allen, participated in experiments to determine questions relating to diffusion, dispersion and the factors pertaining to dispersion and diffusion, in regard to disposal of sewage?

A. I have.

Q. State what they were.

A. We made a large number of experiments, something over 70 in all, for the Metropolitan Sewage Commission, beginning with laboratory experiments, and then going to the Aquarium, where we had a tank devoted to our use, about four feet square and eight feet long, if I remember correctly; and then took a boat and went out

into the harbor at different points and pumped a strong dye into the the harbor at different points and observed the result. We found the result depended very largely on the salinity of the water. With the salinity at Robbins Reef, we discovered the coloring matter in the dye at the surface, after pumping through a 2½ inch hose, at a depth of about 40 feet; while at Mount St. Vincent, in the Hudson, with a lower degree of salinity, it was extremely difficult to discover it when pumped in at a depth of 25 feet.

Q. What are your general conclusions from the diffusion and dispersion experiments that you participated in?

Mr. Riker: The question is objected to on the ground that this inquiry is not within the scope of the order of March 10, 1919, and has been covered by the testimony heretofore taken in this
727 cause.

The Commissioner: Note the objection of counsel for the defendants.

A. My conclusions were that fresh water is very much preferable to salt water for the diffusion of sewage. That was shown very clearly in one special experiment that we made in the Aquarium, where sewage was discharged gently horizontally into the bottom of the tank and where it spread like a blanket about two inches thick over the bottom, diffusing slowly from the top; while when a similar discharge took place into harbor water, the colored liquid rose rapidly in a conical shape and spread over the surface of the water, gradually diffusing from the under side. These results were confirmed by many other experiments. The question of the difference between the top and bottom at Robbins Reef in the percentage of land water was mentioned in Mr. Stearn's evidence. We found in 1909 that while the average percentage at Robbins Reef was 31.2 per cent. in 13 observations made August 23rd and September 1st, 1909, the average at the top was 36 per cent and at the bottom, 29 per cent.

(Whereupon, an adjournment was taken to August 5th, 1919, at 10.30 o'clock a. m.)

728 New York City, August 5th, 1919, 10.30 O'clock A. M.

Present:

Parties and counsel as before noted.

KENNETH ALLEN, recalled as a witness.

Direct examination (continued).

By Dr. O'Sullivan:

Q. Mr. Allen, as Sanitary Engineer of the Board of Estimate and Apportionment of the City of New York, were you delegated to design plans for the relief of the sewage disposal of this City, for the relief of certain polluted areas?

A. I was.

Q. In undertaking the design and recommending the construction of these plans, did you adopt any fundamental assumptions to guide you in your work?

A. Yes, fundamental assumptions were prepared by me, and thoroughly discussed by the Consulting Engineers of the different boroughs, and Mr. Nelson P. Lewis, as Chairman, and these, with certain modifications have been used up to the present time, and are submitted herewith (handing paper).

Dr. O'Sullivan: I offer in evidence fundamental assumptions regarding sewer design, adopted by the Board of Estimate and Apportionment of the City of New York, for guidance in the de-
729 sign and constructions of sewers for the relief of the sewage pollution in the various areas of the Greater City of New York, and ask that it be marked Complainants' Exhibit No. 236.

By Mr. Riker:

Q. When were these fundamental assumptions adopted, Mr. Allen?

A. They were drawn up originally in 1915, and at that time they were discussed by the Bureau of Sewer Plan. That went out of existence the next year and since then the work was entirely in the hands of the Board of Estimate.

Q. When you say they were adopted, do you mean they were adopted officially by any Board or body?

A. Certain ones of those were adopted officially, and others were not adopted, because the Bureau of Sewer Plan went out of existence before they were fully discussed. Those that were adopted are shown there by an asterisk, and those that were not are the others.

Q. By what power do you say they were adopted?

A. The Administrative Committee of the Bureau of Sewer Plan. That Committee consisted of Nelson P. Lewis, Chairman, and the Consulting Engineers of the several Boroughs.

Q. Did that body have an organization and a Secretary?

A. Yes.

Q. And in adopting assumptions regarding sewer designs, did they adopt them so that they became part of their minutes?

730 A. They did.

Q. Where are those minutes?

A. In my office.

Q. Now, the part of this offer that is not in the form of adopted assumptions, how do you say that they were official assumptions for sewer design?

A. The matter of sewer design was left to me after that, and I used them myself, and adapted them to my own use.

Q. So that part of these have been formally adopted by the body you speak of, and the minutes show it, and as to the others they are your working assumptions?

A. Yes.

Q. Have any sewers actually been built under the assumptions that you present in this offer?

A. Practically all the large sewers that have been built since that time.

Q. These are engineering assumptions, are they, merely?

A. Yes.

Mr. Riker: The offer is objected to on the ground that it is not the best evidence, and that, outside of the scope of the order of March 10, 1919.

The Commissioner: The objection of defendants' counsel will be noted.

(The paper was received and marked Complainants' Exhibit 236.)

(Here follows report marked page 730*a*.)

FUNDAMENTAL ASSUMPTIONS

REGARDING

SEWER DESIGN

BOARD OF ESTIMATE AND APPORTIONMENT

1918

NEW YORK vs NEW JERSEY
Complainants Exhibit 236
JAMES D. MAHER
Commissioner.

Sheet 1-# 236.

OFFICE OF THE CHIEF ENGINEER

BOARD OF ESTIMATE AND APPORTIONMENT

CITY OF NEW YORK

May 1, 1918.

FUNDAMENTAL ASSUMPTIONS

Assumption No. 1

The mean dry weather flow shall be taken equal to the average water supply to the area under consideration plus ground water infiltration.

The maximum rate of dry weather flow shall be taken equal to 1½ times the average rate of water supply plus ground water infiltration.

Assumption No. 2

Infiltration of ground water shall be taken as:

40,000 gal. per day per mile of sewer where the invert is 5 ft. or more below the water table.

20,000 gal. per day per mile of sewer where the invert is from 0 to 5 ft. below the water table.

Nil where the invert lies above the water table.

Zones approximately defining the areas in which sewers would conform to each of the above conditions to be determined by the Bureau of Sewers of each borough.

NEW YORK vs NEW JERSEY
Complainants Exhibit 236
JAMES D. MAHER
Commissioner.

Assumption No. 3

The capacity of sewers estimated to carry over 10 m.g.d. shall equal twice the mean dry weather flow = 1-1/3 the maximum flow stated in Assumption No. 1.

When the mean dry weather flow is less than 10 m.g.d. the ratio between the mean dry weather flow and the capacity of the sewer shall be expressed by the formula $x = 15 - 6.6 (8.5 y - y^2 - 13$ in which x = cu. ft. sec. mean dry weather flow. y = ratio of capacity of sewer to mean dry weather flow. (See Diagram No. 1).

The capacity of combined sewers when flowing full shall be determined by the maximum storm run-off to be provided for plus twice the mean dry weather flow.

The capacity of interceptors receiving combined sewage when flowing full shall be two to three times the mean water consumption (depending on the subsequent treatment, cost of construction and of pumping and on conditions regarding disposal of overflow) plus one and one half times the mean infiltration.

Assumption No. 4

The coefficient of friction in Kutter's Formula shall be taken as follows:

For cast iron	.013	For concrete	.013 to .015
For wood	.012	For brickwork	.013 to .015
For vitrified pipe	.013	For glazed tile	.013

The variation if the coefficient for concrete and brick sewers between .013 and .015 permits a certain amount of discretion in the design to allow for different qualities of workmanship and materials.

NEW YORK vs NEW JERSEY
Complainants Exhibit 236
JAMES D. MAHER
Commissioner.

Assumption No. 5

Wherever practicable the least mean daily velocities to be assumed for conditions of development for which the sewer is designed and without which means for flushing and cleaning out deposits shall be provided, shall be:

For sewers on the separate system 2.25 ft. sec.
For sewers on the combined system 2.50 ft. sec.

Assumption No. 6

In general studies of main drainage and sewage disposal, the population of New York shall be taken as that shown by Diagram No. 2.

Assumption No. 7

The per capita water supply based upon the resident population of each borough shall be assumed as follows, in gallons per day:

Year	Man & Bronx	Bklyn.	Queens & Rich.	New York (approx.)
1915	105	79	100	96
1920	116	86	100	104
1925	122	89	100	108
1930-1960	125	90	100	110

Kenneth Allen,

Sanitary Engineer.

Note: Fundamental Assumptions Nos. 1, 2, 4 and 5 were approved by the Administrative Committee, Bureau of Sewer Plan.

NEW YORK vs NEW JERSEY
Complainants Exhibit 236
JAMES D. MAHER
Commissioner.

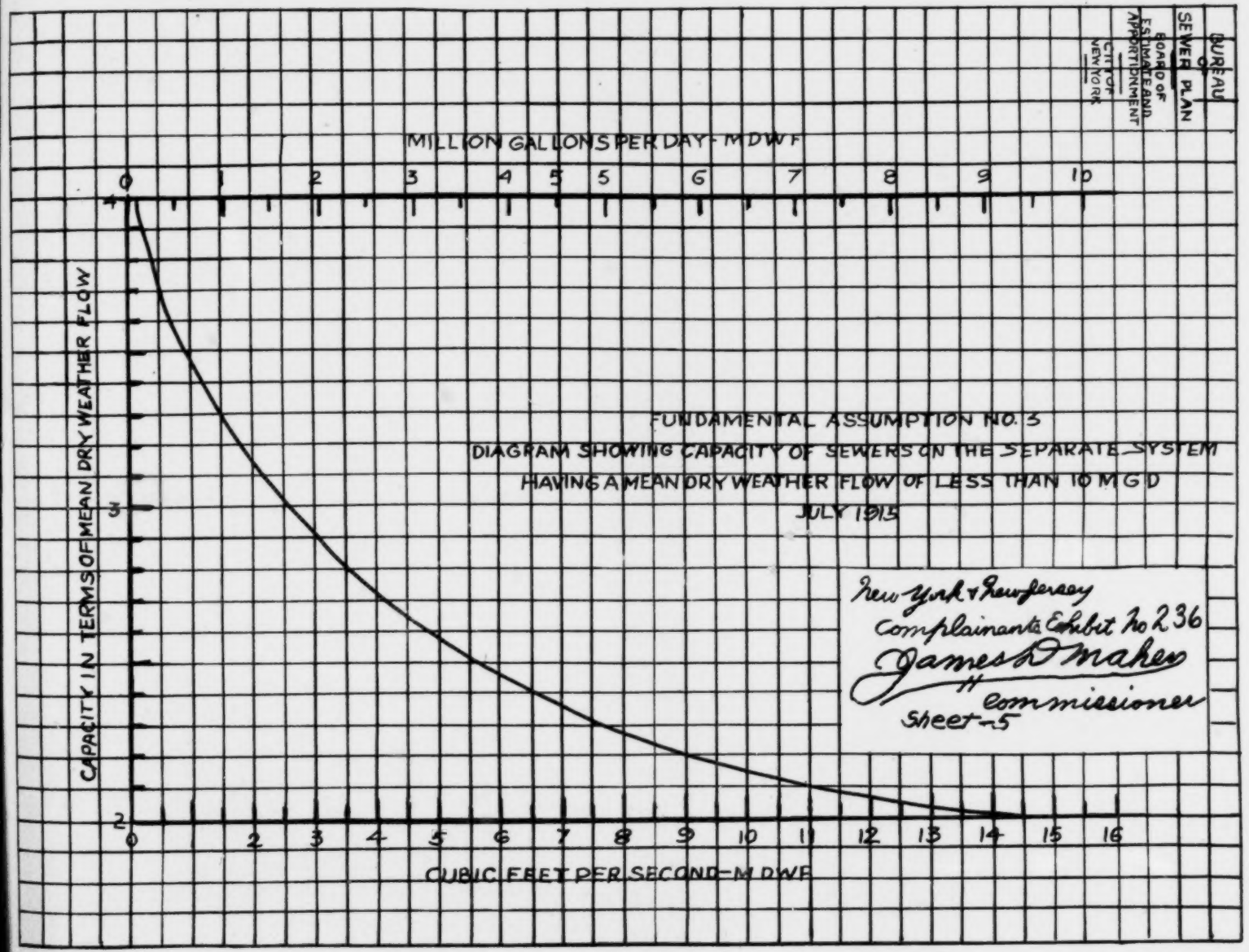
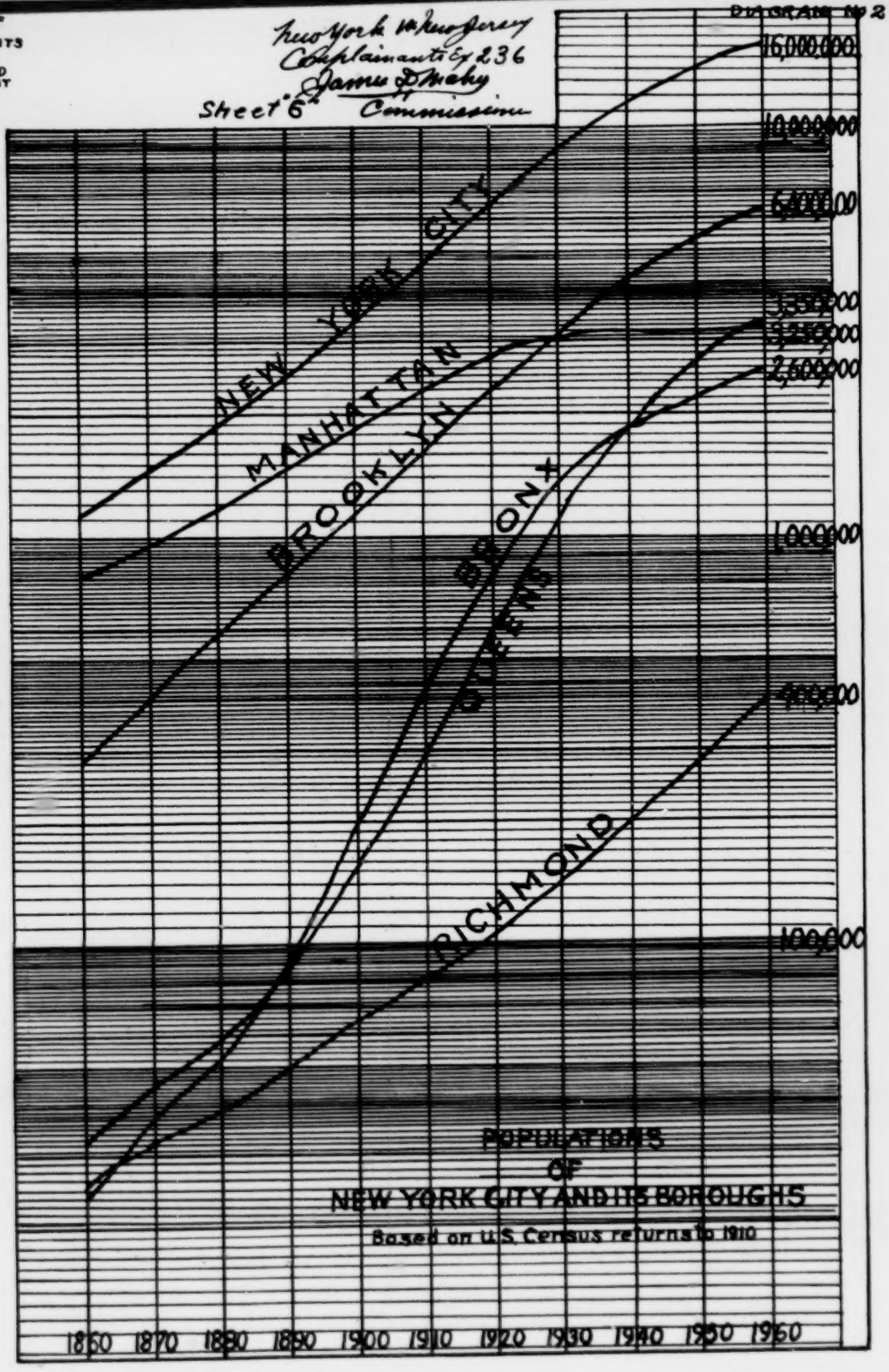

BUREAU OF SEWER PLAN
BOARD OF ESTIMATE AND APPORTIONMENT
CITY OF NEW YORK
MILLION GALLONS PER DAY - M D W F
0 1 2 3 4 5 6 7 8 9 10
CAPACITY IN TERMS OF MEAN DRY WEATHER FLOW
4
3
2
0 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
CUBIC FEET PER SECOND - M D W F
FUNDAMENTAL ASSUMPTION NO. 3
DIAGRAM SHOWING CAPACITY OF SEWERS ON THE SEPARATE SYSTEM
HAVING A MEAN DRY WEATHER FLOW OF LESS THAN 10 M G D
JULY 1915
New York v New Jersey
Complainants Exhibit No 236
James D Makes
Commissioner
Sheet-5

DIAGRAM NO. 1

BUREAU OF PUBLIC IMPROVEMENTS
BOARD OF ESTIMATE AND APPORTIONMENT
CITY OF NEW YORK
FEB. 2, 1916

New York & New Jersey
Complainants Ex 236
James D. Mahy
Commissioner
Sheet "6"

DIAGRAM No 2



Acc. 1178 - File 15

By Dr. O'Sullivan:

Q. Mr. Allen, did you report to the Chief Engineer of the Board of Estimate and Apportionment on the design of outlet
731 sewers, and sewer outlets in 1916?

A. I did.

Q. Have you got a copy of that report?

A. I have (handing paper).

Dr. O'Sullivan: I offer the Report of the Chief Engineer of the Board of Estimate and Apportionment, dated December 29, 1916, embodying the reports and recommendations of this witness who is the Sanitary Engineer to the Board of Estimate and Apportionment, and ask that it be marked in evidence Complainants' Exhibit No. 237.

By Mr. Riker:

Q. When you say that this report embodies your report, do you mean that it is a verbatim reproduction of your reports?

A. That is a series of rules for the design of sewer outlets and outlet sewers, and those rules are verbatim in my words.

Q. Have any plans been built under these specifications?

A. I think all the plans since they were adopted.

Q. How many is that?

A. Oh, I suppose several hundred. I do not know how many. All the sewers of the City.

Q. All the sewers of the City have been subject to interception, and coarse screening and grit chamber treatment?

A. Wherever screening has been adopted, it has conformed to the rules prescribed here, wherever the interception has been adopted, that has been prescribed by these rules.

Q. Did you say that all the sewers of the City had been
732 treated in that way?

A. Not at all.

Q. How many have been?

A. I said that all the sewers that had been designed, conformed to these rules.

Q. All of the rules?

A. All of the rules that they applied to.

Q. How many of the sewers have been built and subjected to interception and treatment by coarse screening, grit chambers and fine screens?

A. A good many plans.

Q. How many?

A. I can not answer the number, but perhaps I should say four or five have been adopted with reference to the fine screening, and a large number to interception. These have not been built as a rule, but are officially adopted by the Board of Estimate as the plans for the City.

Q. What I ask you, I think, was how many had been built.

A. I can not say, but a good many.

Q. A good many have been built?

A. Not intercepting sewers, and not screening plants, but other sewers, those rules applied to.

Q. Mr. Allen, don't you understand my question to be how many sewers have been built by the City of New York since the adoption of these specifications, which involve interception, coarse screening, treatment of grit chambers, and fine screening?

A. None.

Q. Then this is merely a plan that may be put into effect later on, or not, as may be determined on?

733

A. No; it has been a plan that has been put into effect.

Q. How has it been put into effect?

A. By the approval of the official plans, they are called drainage plans that are submitted by the Boroughs to the Board of Estimate for approval, and those in numerous cases have been approved as the official plans of the City.

Q. Have any of them that you know of, been contracted for?

A. None that I think of for interception, and only one fine screening plant.

Q. Where is that?

A. Dyckman Street, Manhattan.

Q. Dyckman Street?

A. Yes. There are, however, one or two plants that are nearly ready for contract.

Q. Have the rules for sedimentation plants been actually approved as intercepting sewers?

A. Yes, in one case.

Q. Where is that?

A. That is at Rockaway Beach.

Q. Rockaway Beach—nothing for the Borough of Manhattan?

A. No.

Q. Or the Borough of Brooklyn?

A. No.

Q. Or the Bronx?

A. No.

Q. Where are the rules with reference to the oxidizing plants contained in this pamphlet that has been offered, in actual operation?

A. In no case.

Q. Where have they been approved for construction?

A. In no case.

Q. This offer, then, contains your rules for the construction of different types of plants, in case they are ordered to be constructed; is that what it is?

734

A. They have been applied in numerous cases that have been adopted already by the City, as official, and the plans on which the works are to be built.

Q. The plans on which the works are to be built?

A. Yes.

New York vs New Jersey
Complainants Exhibit No.237
James D.Maher
Commissioner.

REPORT

SUBMITTED TO THE

BOARD OF ESTIMATE AND APPORTIONMENT

BY THE

CHIEF ENGINEER OF THE BOARD

ON BEHALF OF THE

BOARD OF CONSULTING ENGINEERS

RECOMMENDING THE ADOPTION OF CERTAIN GENERAL RULES GOVERNING THE

DESIGN OF OUTLET SEWERS AND SEWER OUTLETS

WHICH REPORT WAS APPROVED AND WHICH RULES WERE ADOPTED BY THE BOARD OF ESTIMATE AND APPORTIONMENT AT A MEETING HELD ON FEBRUARY 23, 1917

THE BOARD OF ESTIMATE AND APPORTIONMENT

BUREAU OF PUBLIC IMPROVEMENTS

NEW YORK, December 29, 1916.

TO THE BOARD OF ESTIMATE AND APPORTIONMENT,
CITY OF NEW YORK.

Gentlemen:

Realizing that it will be necessary in the near future to subject to some form of treatment a large portion of the sewage of the City of New York before its discharge into the waters of the Harbor, the Consulting Engineers of the several Boroughs, the Engineers of the Borough Sewer Bureaus and the engineering staff of the Board of Estimate and Apportionment have devoted a good deal of attention and much of their time to the formulation of certain general principles which should control the location and design of outlet sewers and sewer outlets. The need of providing for some kind of treatment is so obvious that it will not be discussed in the presentation of the conclusions which have been arrived at. Any treatment will involve the loss of a certain amount of head and in order that such loss of head will not necessitate pumping in some cases and an increased lift where pumping is inevitable, the expense of which pumping will have to be met by the taxpayers of the City, it is very important that the outlet sewers should be constructed at such grades as will reduce this expense to a minimum. The outlets should also be located with a view to securing the greatest possible diffusion of the effluent in order to avoid unnecessary refinements and expense in sewage treatment. The principles governing the design of outlet sewers would apply to all Boroughs, notwithstanding the great difference in conditions which will be found at the outlets owing to the existence or absence of tidal currents, the variations in tidal range, and the degree of treatment which will be required. After full discussion, which has been extended over a number of months, certain general principles and fourteen specific rules, sufficiently flexible to meet various conditions, have been unanimously agreed upon and, at the request of the Consulting Engineers and the Engineers of the Sewer Bureaus, these are submitted to the Board of Estimate and Apportionment with the recommendation that they be formally adopted by the Board and that 300 copies be printed for distribution among the Sewer Bureaus for the guidance of those responsible for the designing of sewers. This statement of principles and the rules referred to are submitted herewith.

Respectfully,

NELSON P. LEWIS,
Chief Engineer of the Board of Estimate and Apportionment.

I. Principles Governing the Design of Treatment Plants.

1. *Interception of Sewage.*

Before taking up questions which enter into the design of outlets it will be well to consider the amount of storm water to be provided for and the treatment to which the effluent has been subjected. Reasonable provision for the conditions mentioned are as follows:

The volume of sewage intercepted to treatment plants shall be:

(a) For separate systems, the maximum flow.

(b) For combined systems:

1. To grit chambers, three times the mean dry weather flow, where grit chambers only are to be provided; elsewhere, the capacity should be equal to that of subsequent treatment processes.

2. To fine screening plants, three times the mean dry weather flow, except in those cases where the cost of interception and pumping would be excessive, in which case the volume may be limited to two times the mean dry weather flow.

3. To sedimentation plants, two times the mean dry weather flow.

The flow to treatment plants may be controlled according to circumstances by overflow weirs, leaping weirs, sewage regulators, or such other devices as are best adapted to the local conditions. Where an accurate control is desired this can best be secured by a properly designed regulator, but overflow weirs are free from the objection of moving parts and are often of simpler design and therefore more applicable to large sewers.

As a general proposition it may be said that:

The interception of sewage should be controlled to within 20 per cent. of the assumed intercepted flow.

2. *Coarse Screens and Grit Chambers.*

By a *Coarse Screen* is meant a screen, usually of parallel bars, with clear openings of from one-half inch to three inches.

Coarse screens are desirable for the protection of pumps from sticks, rags, etc., and to remove coarse floating solids which might promote foaming in Imhoff tanks.

As with grit chambers, coarse screens are not entirely satisfactory without regular attention, especially after storms, and so are more particularly adapted as adjuncts to other plants (pumping, sedimentation, etc.) where attendance is available, or to large outlet sewers.

With proper design and operation the head used up by grit chambers and coarse screens is so slight as to be negligible in its effect on the hydraulic gade.

By *Grit Chamber* is meant an enlargement of the sewer or depression of its invert by which there is a reduction of velocity in the flow of combined sewage or storm water in order to permit the coarse sand and grit to settle out without removing at the same time an appreciable amount of the finer organic sediment or sludge. Desirable velocities for this purpose are from 0.6 to 1.2 feet per second. These velocities are difficult to secure in small installations so that unless a considerable volume—say 5 or 6 mgd.—is effected to one outlet, the operation, however desirable, is likely to be imperfect. In large installations the flow can be controlled by gates so as to pass through 1, 2, 3 or more units as desired. This is a desirable feature in any case.

Grit chambers should be placed before all inverted siphons, pumping stations, Imhoff tanks and usually (depending on the type) in front of important outlets and fine screening plants, receiving combined sewage or storm water. For small installations receiving the sewage from separate systems they may be omitted. Their object is to prevent deposits in the harbor, the clogging of siphons and the sludge pipes of Imhoff tanks and the abrasion of pump plungers and impellers.

3. *Fine Screens.*

By a *Fine Screen* is meant one having openings not over ¼-inch in least dimension and which is automatically cleaned above water.

A well designed screen of the Rienach-Wurl type may be expected to remove from 20 to 30 per cent. of the suspended solids from the sewage. If of the Hamburg type with ¼-inch spacing between the links, 15 per cent. of the suspended solids would probably be removed. In either case the sewage should be reasonably fresh and not broken up by pumping.

Because of the limited amount of suspended matter removed by fine screens, they are only recommended where the harbor water is well supplied with oxygen.

The head used up in passing screens will vary with the type and fineness of screen, the load to which it is subjected and to the thoroughness and frequency or rapidity of cleaning. For plants with units of ordinary size, *i.e.*, with capacities of from 5 to 50 mgd., the loss of head with well-designed screens of the Hamburg or Rienach-Wurl types should not exceed one foot, and so:

> Outlet sewers shown on drainage plans, where it is proposed to treat sewage by screening, should provide for a loss of head for the operation of the screens as great as one foot, where practicable.

4. *Sedimentation Plants.*

By *Sedimentation Plant* is meant a plant for settling the sewage, comprising tanks of the Imhoff type, unless otherwise specified.

Such tanks should remove about half the suspended solids in the sewage and should be employed where the greatest degree of purification is desired without resorting to the more elaborate and costly oxidizing processes.

The head required for the passage of sewage through Imhoff tanks depends largely upon the size of the plant and the arrangement of its channels, but

> For all but exceptionally large sedimentation plants, such as have been proposed for Barren, Ward's, and Riker's Islands, a loss of head due to the flow through the plant amounting to one foot shall be provisionally assumed.

5. *Oxidising Plants.*

By *Oxidising Plant* is meant a plant for the removal of both dissolved and suspended impurities.

Under normal conditions of flow and temperature the effluent from such a plant should contain less than 100 ppm. of suspended solids, or not over 30 per cent. of the total organic matter in the raw sewage, and at least 90 per cent. of the samples tested should give no evidence of putrescibility when subjected to the methylene blue test after standing four days at a temperature of 37 degrees C.

6. *Disinfection Plants.*

By *Disinfection Plant* is intended one which, by the use of liquid chlorine or bleaching powder, destroys the bacteria in a sewage effluent.

Under normal conditions of flow and temperature such treatment should remove from 95 to 98 per cent. of the bacteria contained in the raw sewage, provided the coarser suspended matter has been previously taken out by fine screens or tanks.

7. *Sampling and Analysis.*

The methods of sampling and analysing sewage and sewage effluents to determine the results of processes for treatment shall be those adopted by the American Public Health Association.

II. Principles Governing the Design of Sewer Outlets.

1. *Outlets for Effluents with no more Treatment than by Coarse Screening and Grit Removal.*

Location of Outlets. *Storm Sewers and Storm Water Overflow Sewers* may, in general, discharge at the bulkhead line.

Combined Sewers should be carried to existing pierheads where practicable, except in those cases where it will be necessary within a reasonable period—say six or eight years—to treat, intercept or divert the dry weather flow, having the existing sewer to serve as a storm water overflow, in which case it may provisionally terminate at the bulkhead line. If the treatment, interception or diversion of the dry weather flow is not to be expected until ten or more years, the dry weather flow should, where practicable, be taken to the pierhead line, in which case the storm flow may discharge at the bulkhead line.

Domestic sewage or the dry weather flow intercepted from combined sewers shall be discharged, where practicable, in deep water beyond the pierhead line through submerged outlets.

The *Hydraulic Grade* in the case of outlets at or below the water level slopes upward from the water surface at the outlet and, in order to prevent undue back-flooding in sewers, it is desirable that it should be assumed at such an elevation that this will not occasion damage. For this reason it should be placed at least as high as the highest level reached by the tide. On the other hand such an extreme elevation of the hydraulic grade might interfere with the proper drainage of basements during the entire year while the objectionable condition of flooding is usually of brief duration. There is, however, an argument in favor of keeping the invert at the outlet down below M L T level. In doing this the hydraulic gradient near the outlet is increased during every low tide and the increased velocity which results aids in flushing the sewer in that vicinity. This is desirable as most outlet sewers in New York are necessarily constructed with a very flat gradient and contain deposits caused by the diminished velocities which obtain during high stages of tide.

Taking all these matters into consideration it is recommended that:

Outlet sewers shall be constructed at as high an elevation as is consistent with proper gradients and adequate drainage.

The hydraulic grade at the outlet shall be assumed, in the design of the outlet sewer, to be not lower than the level of mean high tide, except where the top inside of the sewer is submerged more than 20 feet below the elevation of M H T, in which case the hydraulic grade shall be assumed to be not lower than the level of M H T, plus 0.15 feet for every 10 feet of submergence.

2. *Outlets for Effluents from Fine Screening and Sedimentation Plants.*

Where fine screens of the Riensch-Wurl type are contemplated they should be placed at such an elevation as to insure continuous operation.

Therefore:

If the sewage is delivered by gravity to a fine screening plant having screens of the Riensch-Wurl type, or to a sedimentation plant, and thence to the outlet, the hydraulic grade at the outlet in the harbor during periods of maximum sewage flow shall be assumed at 35 per cent. of the mean tidal range at that point above the level of mean high tide. The upper ends of Hamburg or other band screens can be carried sufficiently high to avoid drowning out during high stages of tide and so can be designed with the hydraulic grade at outlet at the level of M H T.

The operation of fine screening should precede pumping whenever practicable, but if the sewage is pumped prior to screening, the lift can readily be increased so as to afford a free flow through the plant.

Therefore, in designing structures between the screens and the outlet:

If the sewage is pumped to a fine screening plant having screens of the Riensch-Wurl type or to a sedimentation plant, the hydraulic grade at the outlet in the harbor during periods of maximum sewage flow shall be assumed at not less than 50 per cent. of the mean tidal range at that point above the level of mean high tide.

Effluents from fine screening and sedimentation plants shall be discharged at or beyond the pierhead line when practicable.

In establishing the hydraulic grade of the sewage entering a screening or sedimentation plant from which the effluent passes by gravity to the outlet there should be added to the hydraulic grade at the outlet (as given in Rules No. 8 and No. 9) the head lost in the outlet sewer between the plant and the outlet at times of maximum flow, plus one foot loss of head in passing through the plant.

In the case of sedimentation plants it is assumed that any excess elevation of tide water above these levels may be accommodated by a slight rise in the level of the tank, provision for which should be made in the elevation of the walls. As, however, it is undesirable to admit harbor water to Imhoff tanks this should be kept out by tide gates, allowing the surface in the tanks to rise only by the admission of sewage.

In general it is the policy to discharge sewage effluents as far from shore, as far below the surface of the water and in as swift currents as practicable. This rule applies more particularly to domestic or combined sewages that have not been treated, but it also applies in less measure to all others.

Therefore:

> Where separate or combined outlet sewers constructed under piers are not to be submerged or built beyond the end of the pier the outlet should be carried to a point within 30 feet of the end of the pier.

Such outlets should, however, be designed with the view of ultimately securing more favorable conditions for diffusion and dispersion of the effluent by being extended beyond the pierhead by one or more submerged pipes into deep water.

Where the submerged outlet sewer extends beyond the pierhead it shall be laid so as to avoid obstruction to either the actual or the legal channel or waterway and so as to avoid injury by dredging operations or the dragging of anchors. Where this condition can be fulfilled the discharge shall be approximately in a horizontal direction; otherwise, in order to bring the outlet above the stream bed, the pipe may terminate in a bend.

Wherever practicable, submerged outlets shall be placed not less than 50 feet beyond the pierhead line nor in less than 30 feet depth of water over the top inside at M L T.

The adoption of the following resolutions is, therefore, recommended:

I. *Resolved*, by the Board of Estimate and Apportionment, that the following rules governing the design of sewage treatment plants and outlet sewers be and hereby are adopted:

Rules Governing the Design of Sewage Treatment Plants and Outlet Sewers.

Rule No. 1. The volume of sewage intercepted to treatment plants shall be:

(a) For separate systems, the maximum flow.

(b) For combined systems:

1. To grit chambers, three times the mean dry weather flow, where grit chambers only are to be provided; elsewhere, the capacity should be equal to that of subsequent treatment processes.

2. To fine screening plants, three times the mean dry weather flow, except in those cases where the cost of interception and pumping would be excessive, in which case the volume shall be limited to two times the mean dry weather flow.

3. To sedimentation plants, two times the mean dry weather flow.

Rule No. 2. The interception of sewage should be controlled to within 20 per cent. of the assumed intercepted flow.

Rule No. 3. Outlet sewers shown on drainage plans, where it is proposed to treat sewage by screening, should provide for a loss of head for the operation of the screens as great as one foot, where practicable.

Rule No. 4. For all but exceptionally large sedimentation plants, such as have been proposed for Barren, Ward's, and Riker's Islands, a loss of head due to the flow through the plant amounting to one foot shall be provisionally assumed.

Rule No. 5. The methods of sampling and analyzing sewage and sewage effluents to determine the results of processes for treatment shall be those adopted by the American Public Health Association.

Rule No. 6. Outlet sewers shall be constructed at as high an elevation as is consistent with proper gradients and adequate drainage.

Rule No. 7. The hydraulic grade at the outlet shall be assumed, in the design of the outlet sewer, to be not lower than the level of mean tide, except where the top inside of the sewer is submerged more than 20 feet below the elevation of M H T, in which case the hydraulic grade shall be assumed to be not lower than the level of M H T, plus 0.15 feet for every 10 feet of submergence.

Rule No. 8. If the sewage is delivered by gravity to a fine screening plant having screens of the Riensch-Wurl type, or to a sedimentation plant, and thence to the outlet, the hydraulic grade at the outlet in the harbor during periods of maximum sewage flow shall be assumed at 35 per cent. of the mean tidal range at that point above the level of mean high tide. The upper ends of Hamburg or other band screens can be carried sufficiently high to avoid drowning out during high stages of tide and so can be designed with the hydraulic grade at outlet at the level of M H T.

Rule No. 9. If the sewage is pumped to a fine screening plant having screens of the Riensch-Wurl type or to a sedimentation plant, the hydraulic grade at the outlet in the harbor during periods of maximum sewage flow shall be assumed at not less than 50 per cent. of the mean tidal range at that point above the level of mean high tide.

Rule No. 10. Effluents from fine screening and sedimentation plants shall be discharged at or beyond the pierhead line when practicable.

Rule No. 11. In establishing the hydraulic grade of the sewage entering a screening or sedimentation plant from which the effluent passes by gravity to the outlet there should be added to the hydraulic grade at the outlet (as given in Rules No. 8 and No. 9) the head lost in the outlet sewer between the plant and the outlet at times of maximum flow, plus one foot loss of head in passing through the plant.

Rule No. 12. Where separate or combined outlet sewers constructed under piers are not to be submerged or built beyond the end of the pier the outlet should be carried to a point within 30 feet of the end of the pier.

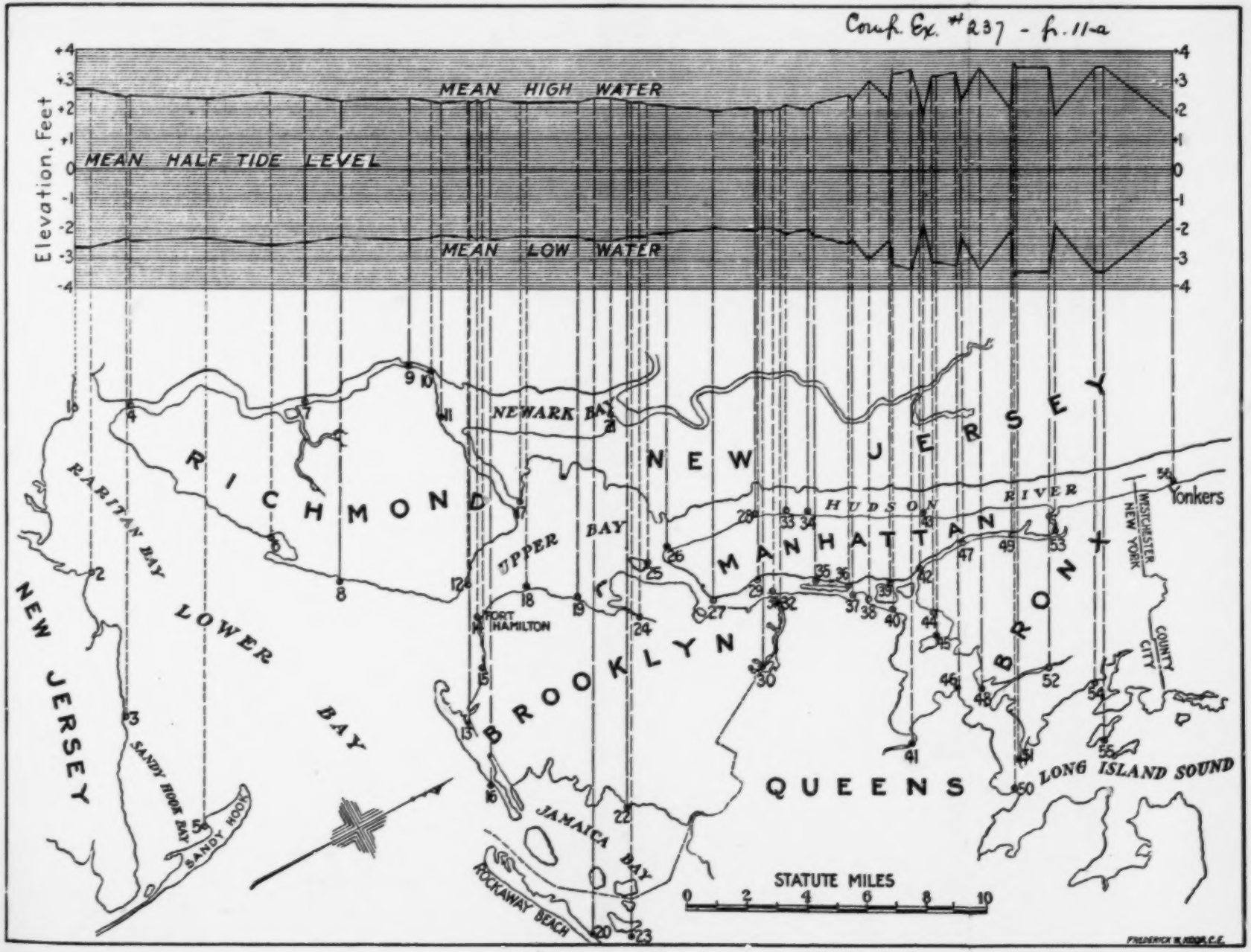
Rule No. 13. Where the submerged outlet sewer extends beyond the pierhead it shall be laid so as to avoid obstruction to either the actual or the legal channel or waterway and so as to avoid injury by dredging operations or the dragging of anchors. Where this condition can be fulfilled the discharge shall be approximately in a horizontal direction; otherwise, in order to bring the outlet above the stream bed, the pipe may terminate in a bend.

Rule No. 14. Wherever practicable, submerged outlets shall be placed not less than 50 feet beyond the pierhead line nor in less than 30 feet depth of water over the top inside at M L T.

II. *Resolved*, That the relation of datum planes to the elevation of mean sea level at Sandy Hook, N. J., used in establishing the grades of sewer outlets and outlet sewers, shall be shown on all drainage plans, and the relation of mean high tide and of mean low tide to mean sea level at Sandy Hook, throughout New York Harbor, shall be as shown on the accompanying diagram prepared by Mr. Frederick W. Koop, Assistant Engineer, Board of Estimate and Apportionment, in connection with his report on Precise Leveling in New York City, and submitted to said Board by its Chief Engineer on October 3, 1914.

(Here follows map mean High, mean Half tide and mean low water page 11-a

Conf. Ex. #237 - f. 11-a



Q. But none of them, except the Dyckman Street case, has been put into actual operation?

A. That is the only disposal plant that has been built by these rules.

(The paper was marked Complainants' Exhibit No. 237.)

(Here follows report marked page 734*a*.)

By Dr. O'Sullivan:

Q. As Sanitary Engineer of the Board of Estimate and Apportionment of this City, Mr. Allen, has it devolved upon you to select areas and plans of disposal, and have those been submitted to the Board of Estimate for the relief of the sewage pollution of these harbor waters?

A. It has. This map shows areas colored which have been studied and informally adopted as the method of collecting and disposing of the sewage of certain areas in New York. Some of these have been officially acted upon and others have not.

Q. You mean not yet?

A. Not yet.

Q. Are they under consideration?

A. Not all at the present time.

Q. What was the object of selecting these areas for dis-
735 posal systems?

A. These have been under active discussion and plans have been submitted for approval of a good many of them and acted upon. These were the more urgent of the areas requiring attention in the City. Of all these plans, the one at Rockaway has been approved. The one shown in red in the Borough of Richmond has been approved.

Mr. Riker: Are you going to offer it?

Dr. O'Sullivan: Yes. I offer the general plan of main drainage for the relief of polluted areas in the waters of New York, surrounding the greater City, and ask that it be marked Complainants' Exhibit No. 238.

By Mr. Riker:

Q. Who prepared this, Mr. Allen?

A. I did.

Q. And the plans that are embodied in this exhibit, in your opinion, are feasible?

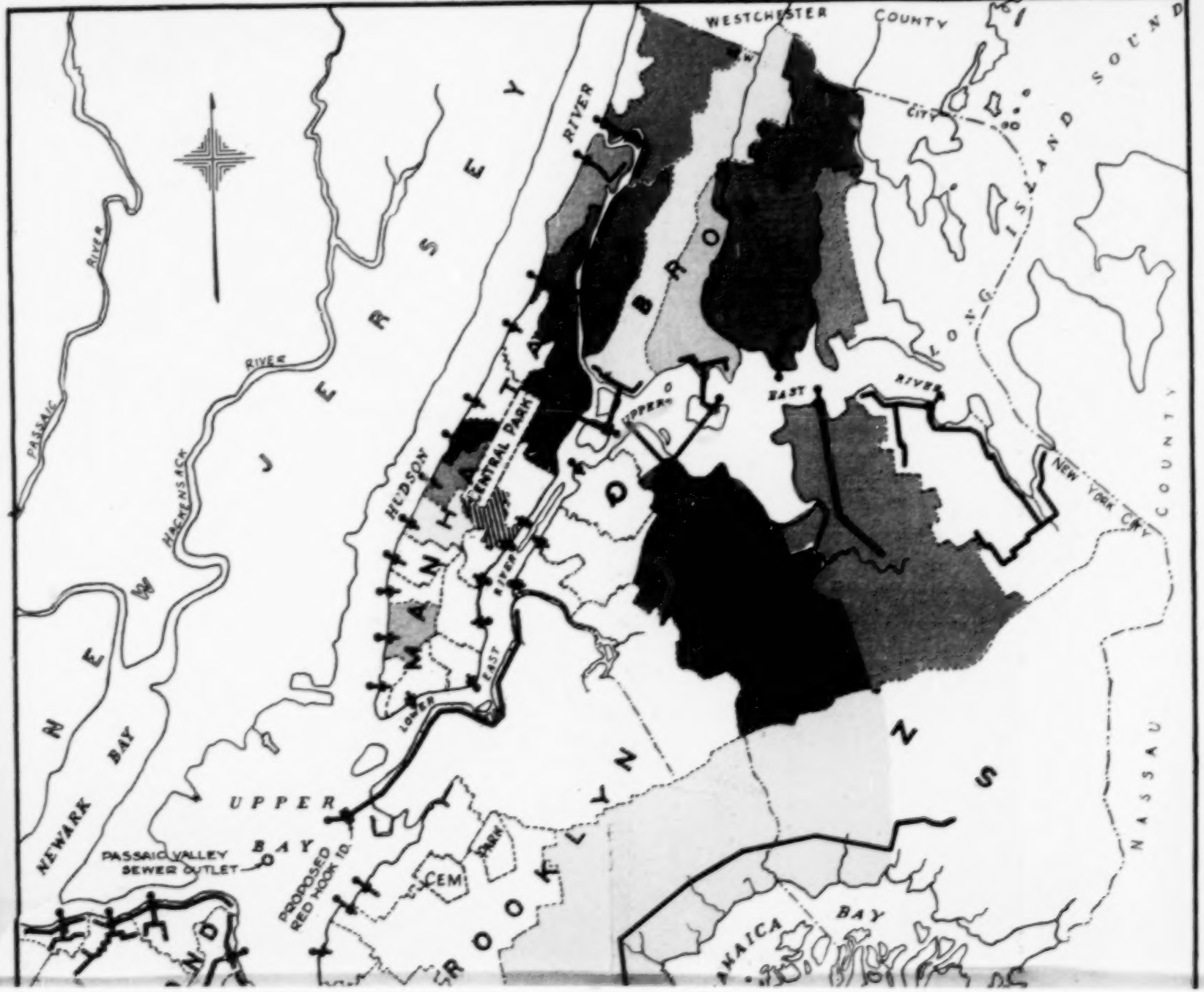
A. Yes.

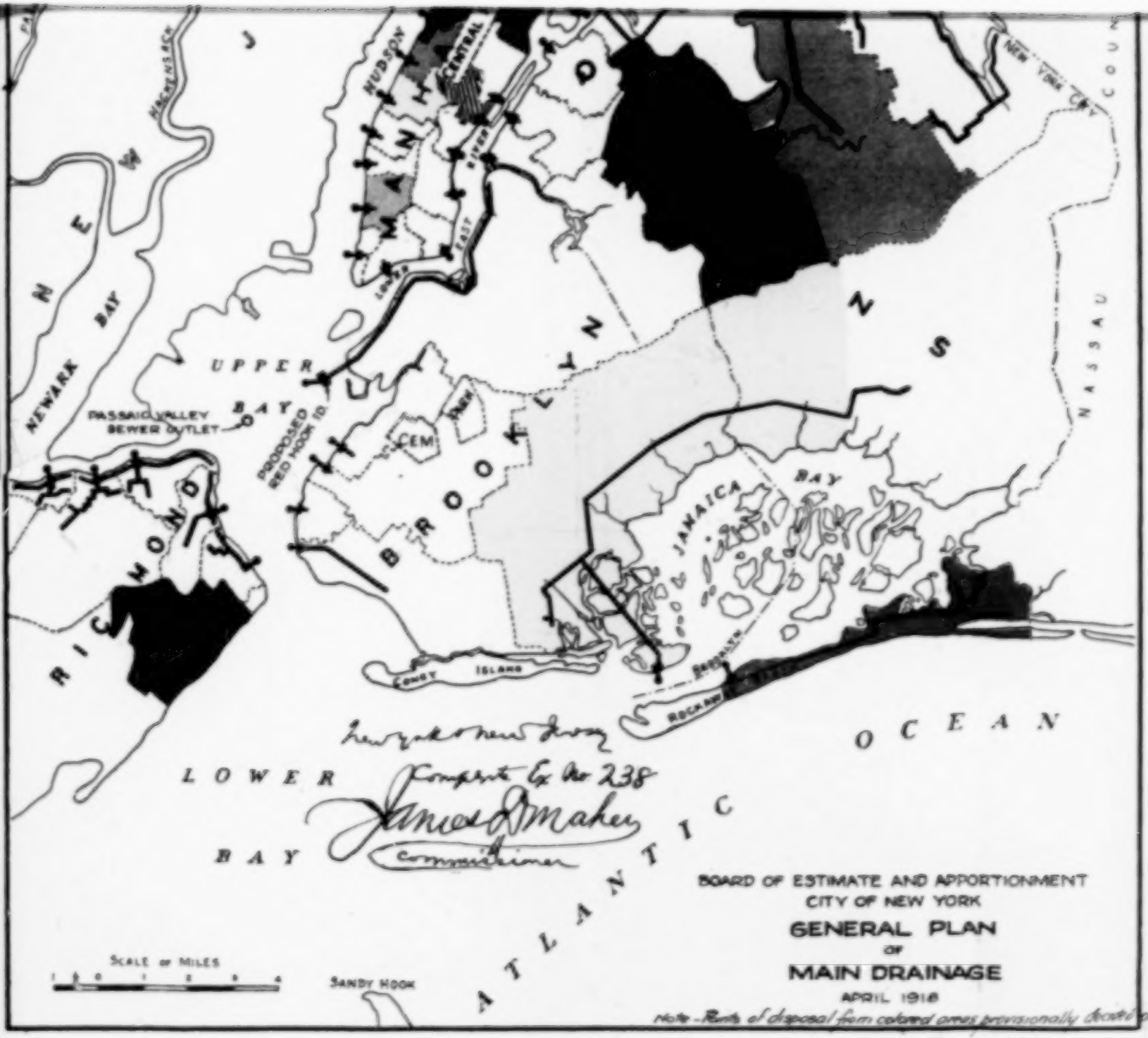
Q. You say the plan that has been embodied in this exhibit has been approved in part. Will you indicate what parts have official approval?

A. Yes.

Q. What are they?

A. The one at the bottom from Far Rockaway to Rockaway Point. The one in Richmond. On the west side of Manhattan, one outletting in Canal Street, and the one outletting at Dyckman Street. The one outletting at 155th Street, was approved by the Administrative Committee of the Bureau of Sewer Plan. The one
outletting at 79th Street is at present being discussed, and
736 will be approved this fall. The one outletting at just north of Ward's Island has been approved with the exception of the extension to Ward's Island. The present plan is to carry the sewer to the foot of 132nd Street, where there will be a temporary


WESTCHESTER COUNTY
LONG ISLAND SOUND
CITY
NEW YORK CITY
NASSAU COUNTY
JERSEY
NEW
PASSAIC RIVER
HACKENSACK RIVER
HUDSON RIVER
MANHATTAN
CENTRAL PARK
UPPER
EAST RIVER
LOWER EAST RIVER
NEWARK BAY
UPPER BAY
PASSAIC VALLEY SEWER OUTLET
PROPOSED RED HOOK ID.
CEM
PARK
BROOKLYN
BAY



No. 292 File 2.1

disposal plant, and later that sewage will go either to Riker's Island or Ward's Island—probably Ward's Island. The point of disposal for the three areas to the right of that in the Bronx has been selected and approved. In Queens the interception of the sewage of that western area has been approved to the foot of Theodore Street, with a temporary outlet between there and Riker's Island. Those are the only ones I think that have been approved.

Q. Are there any records of the approvals that you mention?

A. Those are in the office of the Chief Engineer.

Q. Has not the body or the bodies that have approved of these plans which you mention, a Secretary and records?

A. The Board of Estimate has a Secretary.

Q. Yes; well, is the approval, or these approvals, recorded there, if you know?

A. Yes.

Q. You have testified that you were delegated the function of selecting the areas of disposal; did you select them?

A. I did.

Q. What guided you in the selection of areas for dis-
737 posal?

A. A great many considerations. One was the desirability of having an outlet at that point. Another was the feasibility of collecting the sewage to that point, without a large amount of pumping. Another was the cost of land required for treatment plants, and another was the size of the plant; that is to say, it would be undesirable to have very large plants in certain sections of the City.

Mr. Riker: No objection.

(Paper received and marked Complainants' Exhibit No. 238.)

(Here follows map marked page 737a.)

By Dr. O'Sullivan:

Q. Mr. Allen, is the disposal, in a satisfactory manner, and inoffensively, of the sewage of the City of New York, a simple or complex problem?

A. It is an extremely complex problem, due to the fact that the harbor conditions are so variable, on account of the tide, the wind and the upland flow of water; and due to the fact that the Boroughs are usually separated by bodies of water, and under different administration; and due to the high cost of land in the densely populated areas. In addition to that, there are large areas in Staten Island, Brooklyn, Queens and the Bronx, that are very flat, making it difficult or expensive to collect the sewage to the most desirable points of disposal, without pumping.

Q. In addition to these considerations that render the problem a complex one, in selecting these sites, were you guided to
738 any extent by the available oxygen content in the bodies of waters selected for the outlets?

A. We were. An intensive study was made of the collection of sewage from an area tributary to West 46th Street. A large amount of time and discussion was put on this, and a tentative plan drawn up, of which the print submitted is a sketch of the arrangement of the Riensch-Wurl screens, that it was proposed to use at that point. The plans are still under discussion and are not definitely fixed.

Q. Have you got a design or draft of the plans you have just alluded to?

A. This print shows the arrangement of the three schemes proposed.

Dr. O'Sullivan: I offer the diagram described by the witness, and ask that it be marked Complainants' Exhibit 239.

By Mr. Riker:

Q. This sketch which is being offered at this time by Mr. Allen, was it prepared by you?

A. Yes. It was drawn by a draftsman under my direction.

Q. Has it been adopted by any body or Board?

A. No.

Q. It is then merely a theoretical adoption for this plant, of a certain type of screens; that is all it is, is it not?

A. Yes; because it is made in co-operation with the Borough Engineer, who desired to get the most feasible lay-out for a screening plant on a small area. They were limited in size to the plot shown on the print.

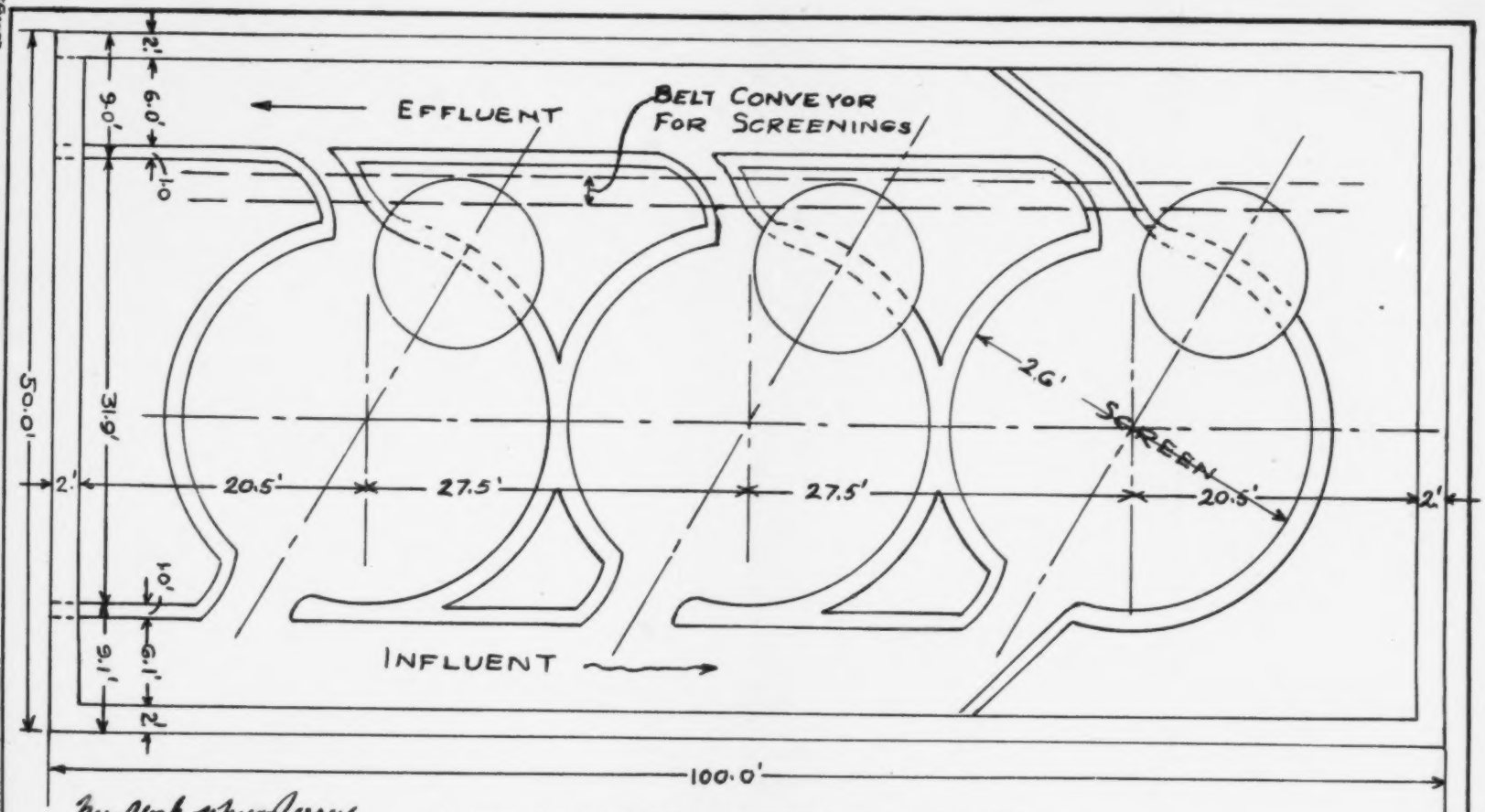
739 Q. Where is the area indicated on the print?

A. It is shown in outline by this rectangle here (indicating) 100 feet by 50.

Q. That is the area of the sewage collection, is it, 100 by 50?

A. That was the area available for a screening plant. There was a large volume of sewage to be collected there, and it was very

Acc. 2306- File 2.1 W46M



New York & New Jersey
Complete Ex 239
James D Maher
Commissioner

WEST 46TH STREET TREATMENT PLANT

SKETCH SHOWING
ARRANGEMENT OF THREE 26 ET
RIENSCH-WURL SCREENS

25

SCALE- 1" = 10'

MARCH 25. 1918

SKETCH NO. 2

WEBSTER

ACC. 2306 - FILE 2.1 W46M

difficult to design a plant that would handle that quantity of sewage.

Q. Then, this is the suggestion of the screening treatment of the sewage of that area?

A. Yes.

Q. It never has been adopted?

A. No.

Q. It is your recommendation?

A. Yes.

Q. You recommended it, I suppose, because you thought it would be effective?

A. Yes.

Q. And would produce the required results for the discharge of an effluent in that plant?

A. Yes.

Mr. Riker: No objections.

(The paper was received and marked Complainants' Exhibit No. 239.)

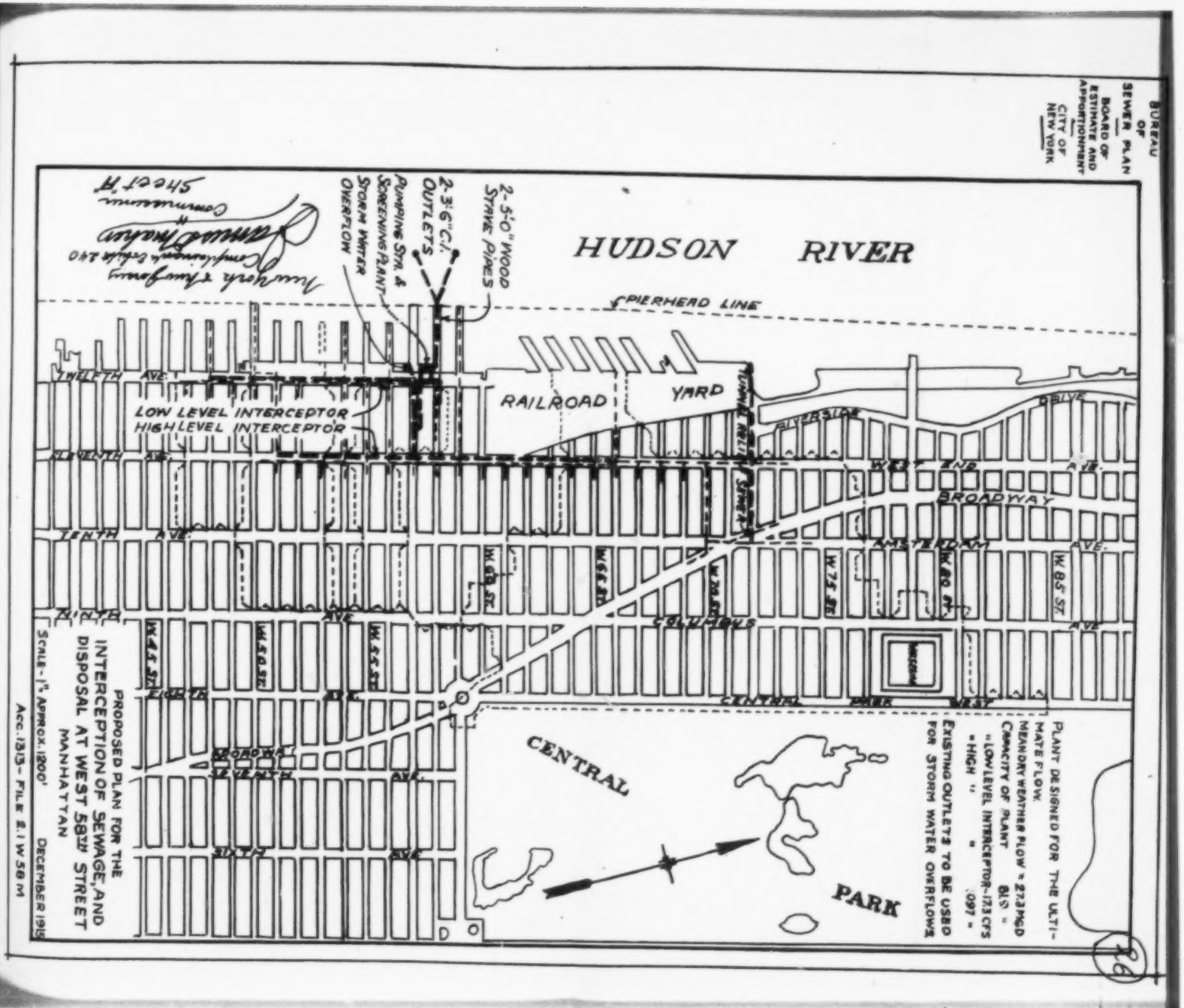
(Here follows sketch marked page 739*a*.)

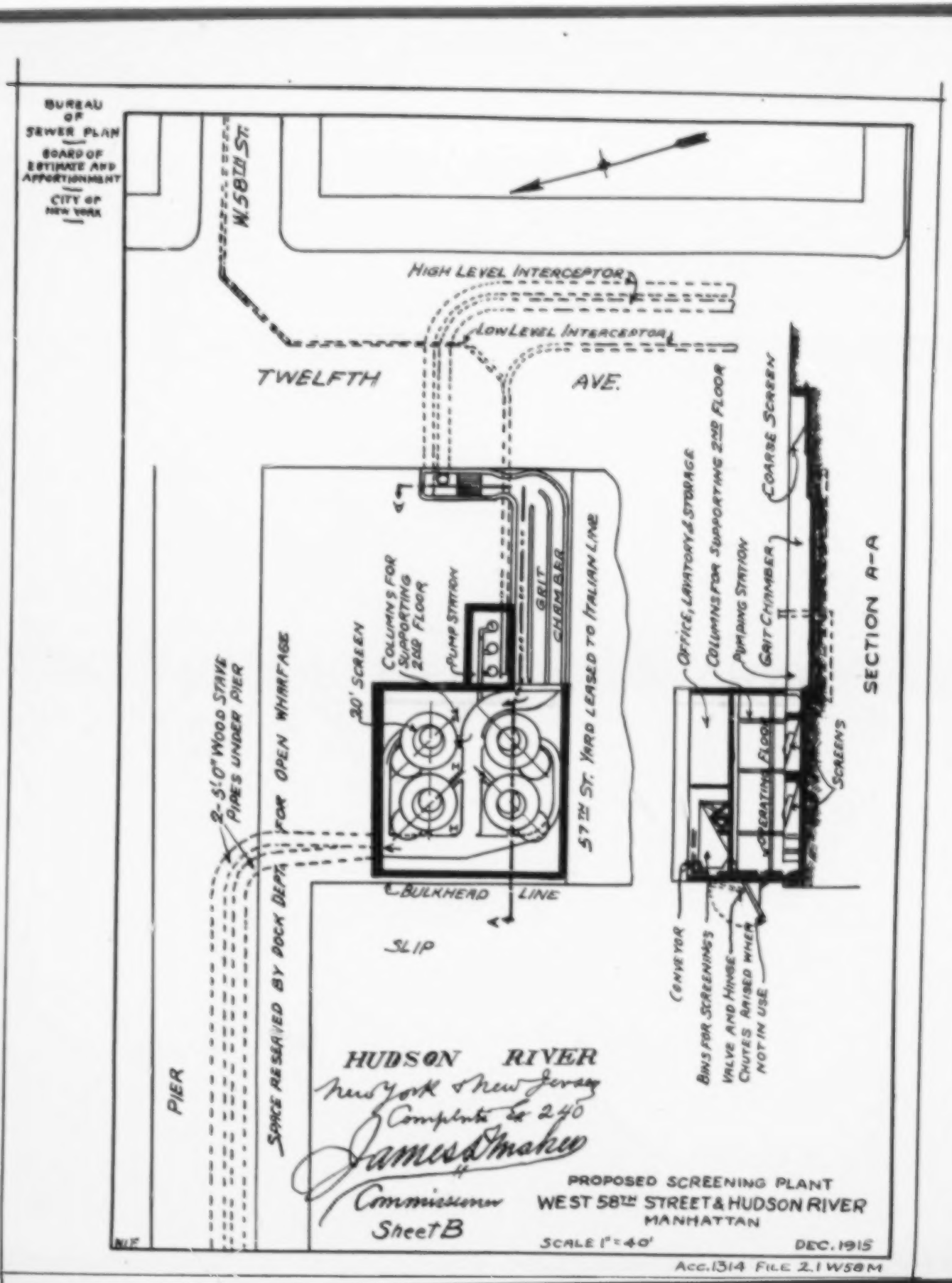
The Witness: The next is a map and a plan for sewage treatment plant at the foot of West 58th Street, Manhattan. This was studied in a similar way to the West 46th Street plan.

Dr. O'Sullivan: I offer the plan just described by this witness for the interception of sewage, and the disposal of sewage at
740 West 58th Street, Manhattan, dated December, 1915, together with the detail of the proposed screening plant at the same location, and ask that both sheets be marked in evidence as Complainants' Exhibit 240.

By Mr. Riker:

Q. Mr. Allen, this is prepared by you or under your direction?
A. Yes.
Q. It is your suggestion for the disposal of the sewage of the area indicated on the first sheet?
A. Yes.
Q. Has it been adopted by any body or any Board?
A. Not formally.
Q. It was prepared by you in pursuance of the delegation to you of the selection of areas and method of treatment of sewage, for the relief of New York?
A. Yes. The matter was discussed with the Engineer of the Bureau of Sewers, and they agreed to this as the proper plan to be followed.
Q. Having been recommended by you for adoption, you believe it to be feasible?
A. I do.
Q. That the treatment proposed will produce an effluent which can be safely and inoffensively discharged into the Hudson River?
A. Yes.
Q. Does the plan indicate at what distance from the shore line the discharge is to be made?
A. I am not sure whether the figure is on there, or whether it is shown only by scale.
Q. This, I think you said, was prepared in 1915?
741 A. I think so.
Q. That is the date on it, December, 1915?
A. Yes.
Q. And not yet approved by any Board?
A. No.
Q. Therefore, not adopted?
A. No.
Q. And not put under contract?
A. No.
Q. Therefore, not actually constructed?
A. No.
Q. This indicates purely and simply a screening plant, does it not?
A. Yes, fine screening.
Q. Fine screening, that is all?




BUREAU OF SEWER PLAN
BOARD OF ESTIMATE AND APPORTIONMENT
CITY OF NEW YORK
W. 58TH St.
HIGH LEVEL INTERCEPTOR
LOW LEVEL INTERCEPTOR
TWELFTH AVE.
20' SCREEN
COLUMNS FOR SUPPORTING 2ND FLOOR
PUMP STATION
GRIT CHAMBER
57TH St. YARD LEASED TO ITALIAN LINE
2-5'0" WOOD STAVE PIPES UNDER PIER
SPACE RESERVED BY DOCK DEPT. FOR OPEN WHIMPAGE
BULKHEAD LINE
SLIP
PIER
OFFICE, LAVATORY & STORAGE
COLUMNS FOR SUPPORTING 2ND FLOOR
PUMPING STATION
GRIT CHAMBER
COARSE SCREEN
OPERATING FLOOR
SCREENS
SECTION A-A
CONVEYOR
BINS FOR SCREENINGS
VALVE AND HINGE
CHUTES RAISED WHEN NOT IN USE
HUDSON RIVER
New York & New Jersey
Complete to 240
James A. Makey
Commissioner
Sheet B
PROPOSED SCREENING PLANT
WEST 58TH STREET & HUDSON RIVER
MANHATTAN
SCALE 1" = 40'
DEC. 1915
ACC. 1314 FILE 2.1 W58M

A. I think there is a grit chamber—yes, there is a grit chamber and fine screening.

Q. Grit chamber and fine screening only?

A. Yes.

Mr. Riker: No objection.

(Paper marked Complainants' Exhibit No. 240.)

(Here follows map marked page 741a.)

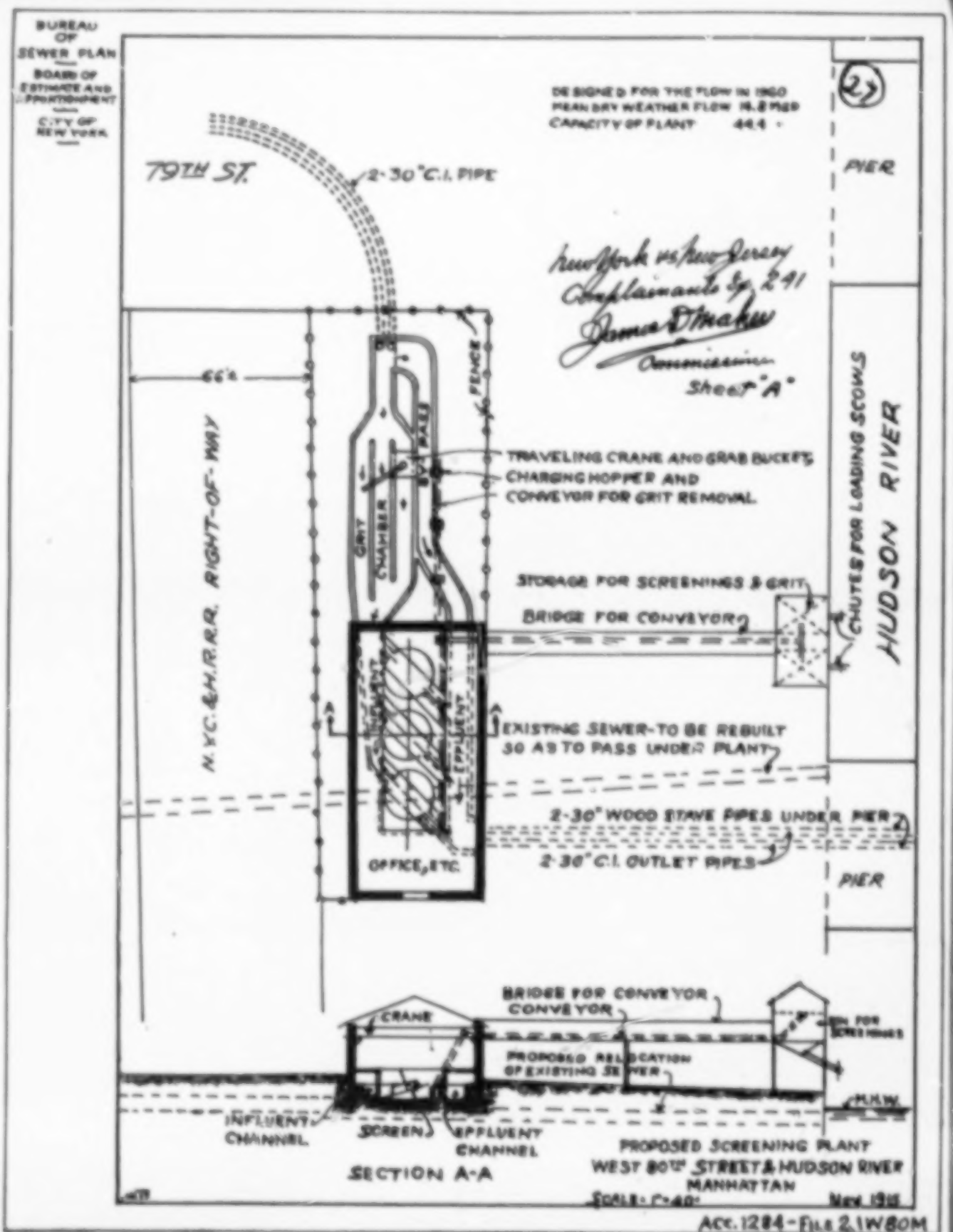
By Dr. O'Sullivan:

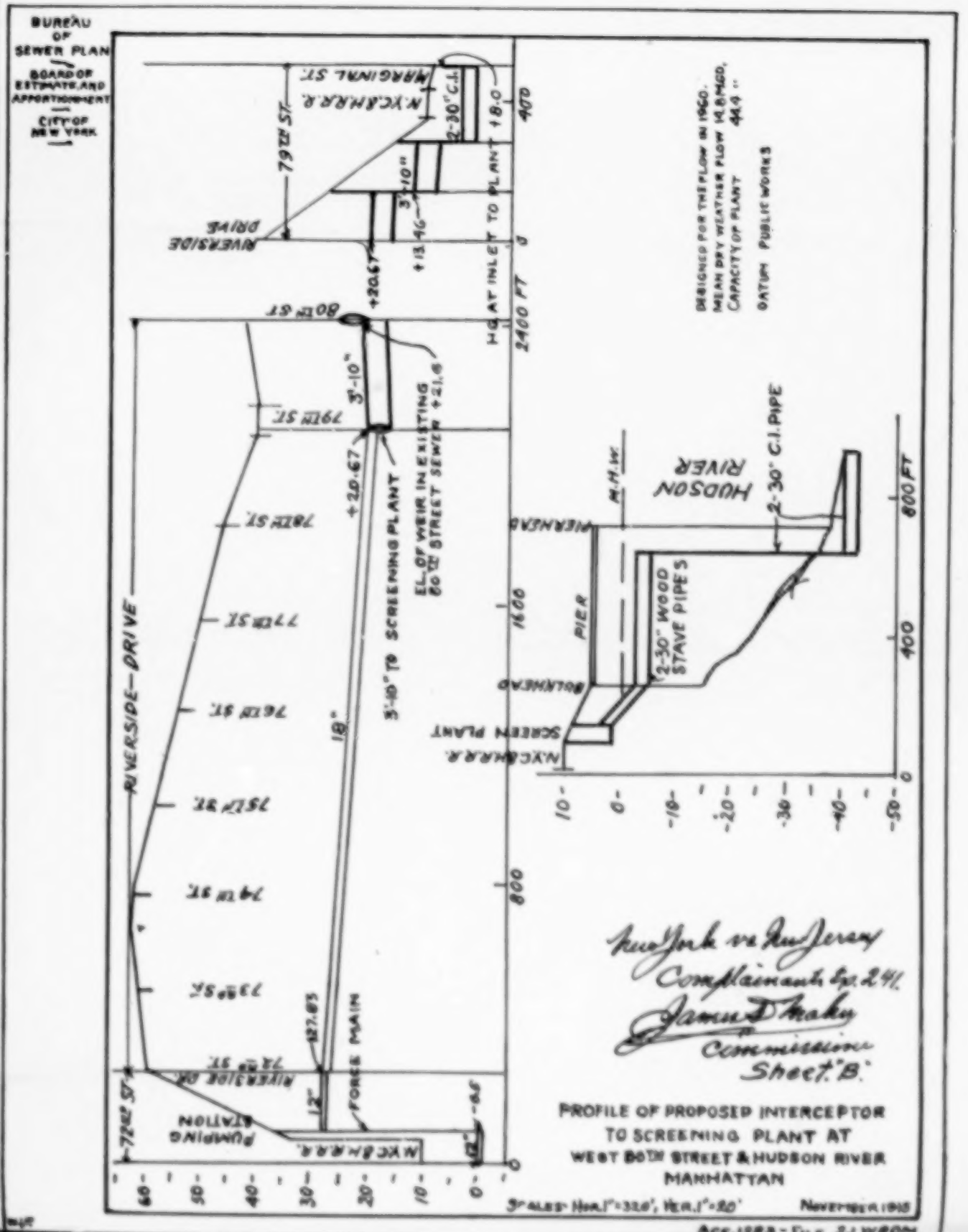
Q. Mr. Allen, were you delegated to design plants for the disposal of sewage, at 80th Street?
A. I was.
Q. If so, have you done so, and have you produced the designs?
A. I have here three prints showing a plan of the area and interception; one showing the profiles of the intercepters, and one showing the lay-out for a screening plant for the foot of West 80th Street.

Dr. O'Sullivan: I offer the three blue-prints produced by this witness in relation to the sewage disposal scheme for West 80th Street, Manhattan, and ask that they be marked in evidence
742 as Complainants' Exhibit 241.

By Mr. Riker:

Q. Were these plans prepared by you?
A. Yes.
Q. At the date that is placed at the bottom of these sheets?
A. Yes.
Q. In the year 1915?
A. I think so; that particular plan is up for discussion now, and it will probably be adopted this fall.
Q. It has not yet been adopted?
A. No.
Q. When was it presented for adoption?
A. It has not been presented yet for adoption.
Q. You never presented it for consideration?
A. No, not for adoption. I presented the plan with a brief report to the Chief Engineer, but not for adoption.
Q. Was this a special delegation of duty to you, or was it part of your general duty?
A. No; it was part of my general work.
Q. Can you tell what area is involved in this plan?
A. I am not sure whether that plan shows the whole area. The plan does not show the whole area. I have it outlined on a map in my office.
Q. It is incomplete in that respect, is it, not showing the whole area?
A. The print does not show the whole area. The print is not intended to show the whole area, but shows the interception,
743 the intercepter from 72nd Street to 80th Street.
Q. And the treatment that is indicated is the same as in the last exhibit?
A. Same as the others.
Q. In preparing this plan under the delegation of duty to you, for what length of time is it designed?
A. Up to the year 1960.
Q. Do you consider it to be a feasible plan?
A. I do.


BUREAU OF SEWER PLAN
BOARD OF ESTIMATE AND APPORTIONMENT
CITY OF NEW YORK
DESIGNED FOR THE FLOW IN 1960
MEAN DRY WEATHER FLOW 16.8 MGD
CAPACITY OF PLANT 44.4 "
79TH ST.
2-30" C.I. PIPE
PIER
New York vs New Jersey
Complainants Ex. 241
Sheet "A"
66'-0"
N.Y.C. & H.R.R.R. RIGHT-OF-WAY
FENCE
TRAVELING CRANE AND GRAB BUCKETS
CHARGING HOPPER AND
CONVEYOR FOR GRIT REMOVAL
GRIT CHAMBER
STORAGE FOR SCREENINGS & GRIT
BRIDGE FOR CONVEYOR
CHUTES FOR LOADING SCOWS
HUDSON RIVER
EFFLUENT
EXISTING SEWER-TO BE REBUILT
SO AS TO PASS UNDER PLANT
2-30" WOOD STAVE PIPES UNDER PIER
2-30" C.I. OUTLET PIPES
OFFICE, ETC.
PIER
BRIDGE FOR CONVEYOR
CONVEYOR
CRANE
PROPOSED RELOCATION OF EXISTING SEWER
M.H.W.
INFLUENT CHANNEL
SCREEN
EFFLUENT CHANNEL
SECTION A-A
PROPOSED SCREENING PLANT
WEST 80TH STREET & HUDSON RIVER
MANHATTAN
SCALE: 1"=40'
Nov. 1915
ACC. 1284 - FILE 2.1W80M


BUREAU OF SEWER PLAN
BOARD OF ESTIMATE AND APPORTIONMENT
CITY OF NEW YORK
DESIGNED FOR THE FLOW IN 1960.
MEAN DRY WEATHER FLOW 14.8 MGD.
CAPACITY OF PLANT 44.4 "
DATUM PUBLIC WORKS
RIVERSIDE DRIVE
79TH ST.
80TH ST.
78TH ST.
77TH ST.
76TH ST.
75TH ST.
74TH ST.
73RD ST.
72ND ST.
N.Y.C.&H.R.R.R.
MARGINAL ST.
2-30" C.I.
3'-10"
+20.67
+13.46
+8.0
HG AT INLET TO PLANT
2400 FT
1600
800
0
400
3'-10" TO SCREENING PLANT
EL. OF WEIR IN EXISTING 80TH STREET SEWER +21.6
18"
127.83
12"
FORCE MAIN
PUMPING STATION
HUDSON RIVER
M.H.W.
PIER
PIERHEAD
BULKHEAD
SCREEN PLANT
2-30" C.I. PIPE
2-30" WOOD STAVE PIPES
800 FT
New York vs New Jersey
Complainants Exp. 241.
James D. Maher
Commissioner
Sheet "B"
PROFILE OF PROPOSED INTERCEPTOR
TO SCREENING PLANT AT
WEST 80TH STREET & HUDSON RIVER
MANHATTAN
SCALES: HOR. 1" = 320', VER. 1" = 20'
NOVEMBER 1915
ACC. 1283 - FILE 21 W80M

27

PIERHEAD LINE

HUDSON RIVER

1100'

UNDER CONTROL OF DEP'T OF DOCKS

30" CAST IRON PIPE

2-30" WOOD STAVE PIPES UNDER PIER

New York vs New Jersey
Amplification of Ep 241
James D Makin
Commissioner
Sheet "C"

EXISTING OUTLET TO BE REBUILT

TIMBER BASIN
DEP'T. OF DOCKS

PROPOSED GRIT CHAMBER AND SCREENING PLANT

FREIGHT YARD

RIGHT OF WAY

PROPOSED PUMPING STATION

DROP MANHOLE

2-30"

3'-10"

DESIGNED FOR THE FLOW IN 1960
MEAN DRY WEATHER FLOW 14.8 MGD
CAPACITY OF PLANT 444 "

N.Y.C. & H.R.R.R.

WEIR

PROPOSED 18" INTERCEPTOR

RIVERSIDE DRIVE

3'-10"

WEST END AVE.

W. 67TH ST.
W. 68TH ST.
W. 69TH ST.
W. 70TH ST.
W. 71 ST ST.
W. 72ND ST.
W. 73RD ST.
W. 74TH ST.
W. 75TH ST.
76TH ST.
ST.
ST.
ST.
ST.
ST.
ST.
ST.
W. 77TH
W. 78TH
W. 79TH
W. 80TH
W. 81 ST
W. 82ND
W. 83RD

BROADWAY

AMSTERDAM AVE.

CITY OF NEW YORK
BOARD OF ESTIMATE & APPORTIONMENT
BUREAU OF SEWER PLAN
PROPOSED INTERCEPTOR - RIVERSIDE DRIVE
FROM 72ND STREET TO 80TH STREET
MANHATTAN

SCALE - 1" = 300'

OCTOBER 1915

No 122 - FILE 21 W80M

Q. And it will produce an effluent which will be inoffensively and safely discharged into the Hudson River, as indicated on the plan?

A. Yes.

Q. In adopting 1960 for this particular plant, is that exceptional, or is that your general rule?

A. That is the general practice, with the exception of outlying areas where we have based our plans often on 1950 population. For instance, the lower part of Staten Island and the outlying parts of the Bronx and Queens.

Q. But, for Manhattan and Brooklyn——

A. 1960.

Q. 1960 is the general rule?

A. Yes.

Mr. Riker: No objection.

(Here follows diagram marked page 743*a*.)

By Dr. O'Sullivan:

Q. In the discharge of your duties as Sanitary Engineer to the Board of Estimate and Apportionment, Mr. Allen, did you design plans for the sewage disposal for 155th Street, and if so, will you produce them?

744 A. I did. This print shows the collection of sewage from a large area in Manhattan and the Bronx, to a point at West 155th Street. It involved a large amount of study, and the co-operation of the two Boroughs, that of the Bronx and that of Manhattan. Frequent meetings were held before, and by the administrative Committee of the Bureau of Sewer Plan, and this plan was adopted by them as the proper one to follow. I might explain that before construction is taken up on any project, the Borough presents what is called a drainage plan, which is approved by the Board of Estimate as a whole. This has never reached that stage. Its approval has been by the Administrative Committee of the Bureau of Sewer Plan. The accompanying drawing shows the lay-out of two possible screening plants at that location. The amount of sewage would as I say, be large, and while the plan shows fine screening only, it is possible that in time some further treatment will be required, especially at times of extreme low water in the Hudson River.

Q. Do the plans you have now produced, contemplate the installation of screening, and other sewage disposal devices adjacent to Riverside Drive?

A. Yes.

Dr. O'Sullivan: I offer the plans just described by this witness, and I ask that they be marked in evidence as Complainants' Exhibit No. 242.

By Mr. Riker:

Q. When was this diagram prepared, Mr. Allen?

745 A. I think it was the same year, 1915—yes.

Q. Was it prepared by you or under your direction?

A. Yes.

Q. The top sheet, the smaller diagram, was that prepared from a survey, or taken from a map?

A. That was taken from another map. The different Boroughs had their drainage areas shown on special maps by which the selected area can be readily outlined.

Q. This contains your recommendation, does it, of the area to be served by this disposal plant?

A. It does.

Q. Has it been adopted by any Board or body?

A. As I stated, it was adopted by the Administrative Committee of the Bureau of Sewer Plans. That is as far as it has gone.

Q. Well, is that an official adoption, Mr. Allen?

A. Yes, so far as it goes.

Q. Well, how far does it go?

A. It controls all the following design relating to those areas concerned, until the time comes up for the presentation of the drainage plan, the formal drainage plan by the Boroughs for approval by the Board of Estimate. If that drainage plan should not conform to this, it would not be approved, unless reason was shown why there should be a change.

Q. Can you state the area involved in this plan; does it appear on this plan itself? A. It does not. I have the area, but I do not have it here.

746 Q. It does not appear on the plan?

A. No.

Q. This large sheet shows the proposed works, does it not?

A. Yes. There is an outlet plant shown there. There are two possible layouts.

Q. Has that been adopted also?

A. No; that is as with the others. They belong together. It was adopted by the Bureau of Sewer plan.

Q. The Bureau of Sewer Plan is out of office, is it not? It does not exist any longer?

A. It does not now, no.

Q. What body succeeded to its functions?

A. The general engineering office of the Board of Estimate.

Q. The large sheet showing the alternative locations and plans of disposal was prepared by you also?

A. Yes.

Q. And where is the original of this plan?

A. In my office.

Q. Did you say that it has not been adopted by the Committee that you spoke of before?

A. I said it was adopted.

Q. It was adopted?

A. Yes.

Q. So that it is quite as official as the area plan?

A. Yes.

Q. As part of the duty delegated to you, you selected the area to be served by this disposal plan?

A. Yes.

Q. And you advised and recommended the types of works that were indicated on this plan?

A. Yes.

Q. What treatment is involved, as shown by this plan?

747 A. Grit chambers, and fine screening.

Q. Anything else?

A. No; no, unless it be found desirable later.

Q. I asked you whether anything else is shown by the plan?

A. No.

Q. The plan, as adopted, involves grit chambers and fine screening?

A. Yes.

Q. I observe that the plan as presented, involves submerged outlet pipes?

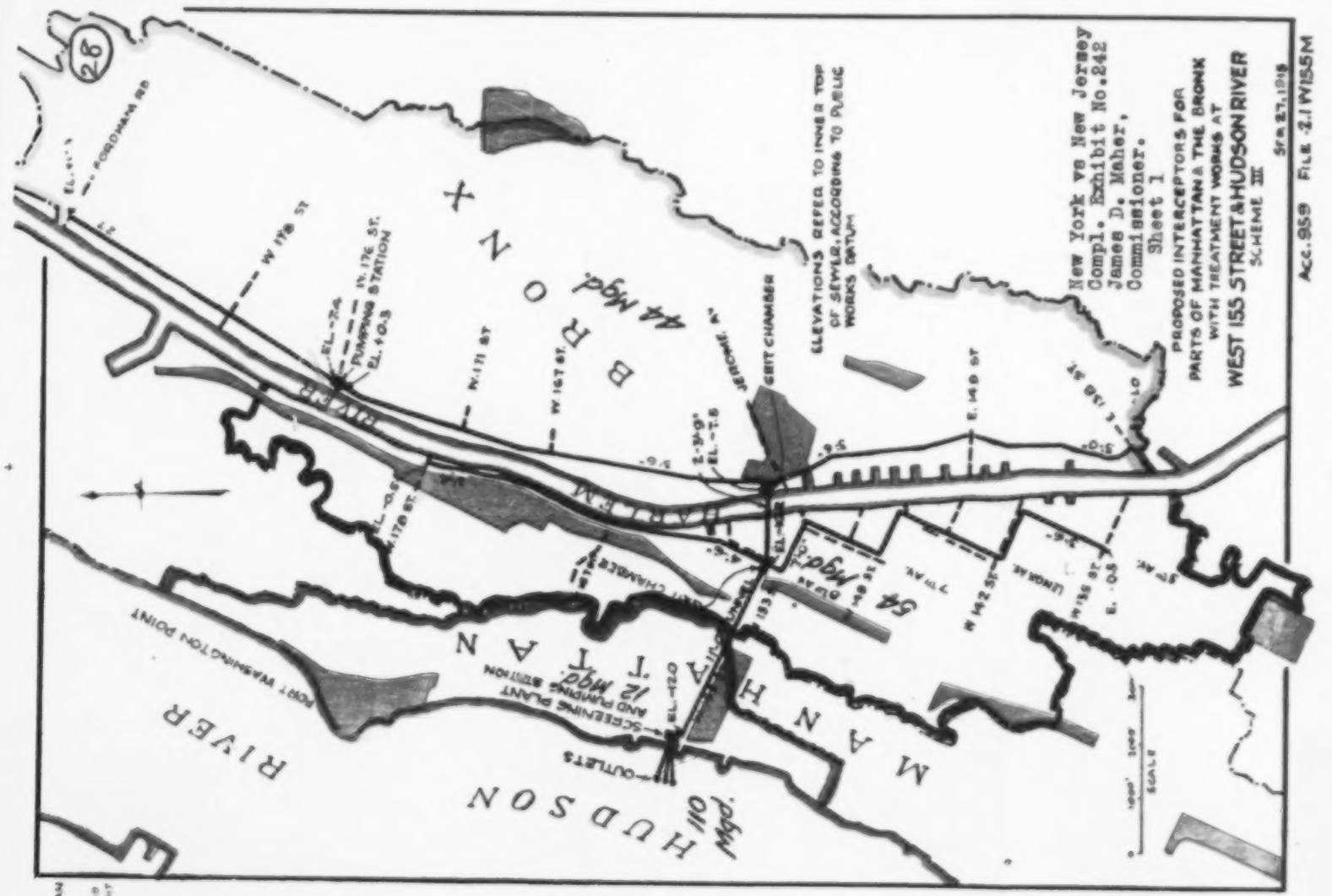
A. Yes.

Q. They are shown here, are not they?
A. Yes.
Q. At what depth, as indicated on this plan?
A. Not less than thirty feet—I think it is forty.
Q. Does the plan indicate the volume of sewage to be disposed of?
A. It does.
Q. How much is it?
A. 110,000,000 gallons a day.
Q. How much?
A. 110,000,000 gallons a day.
Q. Does the plan indicate the area of the works required for the carrying out?
A. It does.
Q. Do you consider the plan a feasible one?
A. Yes.
Q. And that it will produce an effluent, which, when discharged into the Hudson River, will be inoffensive and safe?
A. I would not say as to that. In the future, it may be necessary to treat that sewage more thoroughly.
Q. For the volume of sewage that is indicated in this plan?
A. About that volume. I can not say just when. That
748 is tentative. It would depend on the conditions that arise at that time.

Mr. Riker: No objection.

(The paper was marked Complainants' Exhibit No. 242.)

(Here follows diagram marked page 748a.)



CHART

TOO

LARGE

FOR

FILMING

By Dr. O'Sullivan:

Q. Mr. Allen, the designs for screening and grit chambers that appear in the exhibits 242, 241 and 240, are those plans and designs contemplated to deal with sewage, that is approximately 15 to 20 minutes old?

A. It will be fresh sewage, but some of it might be older than that. I should say that perhaps half an hour would be a safe figure, perhaps half an hour.

Q. And sewage of that age remains intact, does it not?

A. Yes. It remains fresh, as it is usually so-called.

Q. And is readily removed, is it not, by fine screens?

A. In that condition, it is not offensive to the smell, and the large particles are not greatly broken up, or decomposed. These plans contemplate screening before pumping, so that they will not be broken up by pumping. It makes a great difference in the efficiency of the plant whether that is the case or not.

Q. Whether what is the case?

A. Whether the sewage is old, and whether it has been pumped.

Q. When sewage is old, what happens when it is pumped?

A. When sewage is old, besides being offensive to the
749 smell, the particles are decomposed and broken up, so that when it becomes septic, it is quite free from the large masses of matter, but very foul in character.

Q. And in that condition, does screening have any importance or any material effect on it?

A. Screening would have very little effect on a septic sewage.

Q. Did you make any designs for the disposal of sewage?

A. The plan which I have here, contemplates the disposal of the same sewage at another point. It was the original intention to carry that sewage to Fort Washington Point, which is a point that is more favorably located for disposal than the one recommended in the last exhibit.

Q. Meaning the one at Riverside Drive?

A. At 155th Street, Yes.

Q. And Riverside Drive?

A. Yes; but the cost of collection was so much greater here, and the cost of laying the submerged outfall would have been so much greater, that this plan was finally abandoned. It was simply handed in to indicate the thoroughness with which the study was made. The water at Fort Washington Point is very deep, which makes it costly, and it would require a discharge quite near the shore. The water at 155th Street is not so deep, and it is farther from the channel of the river. Therefore, it was provided in the 155th Street plan, to carry the submerged outfalls, for at least,
1,000 feet from shore, and the configuration of the bottom
750 is such that they can be carried much further, and still obtain a satisfactory submergence.

Q. Have these plans that you now produce, been adopted?

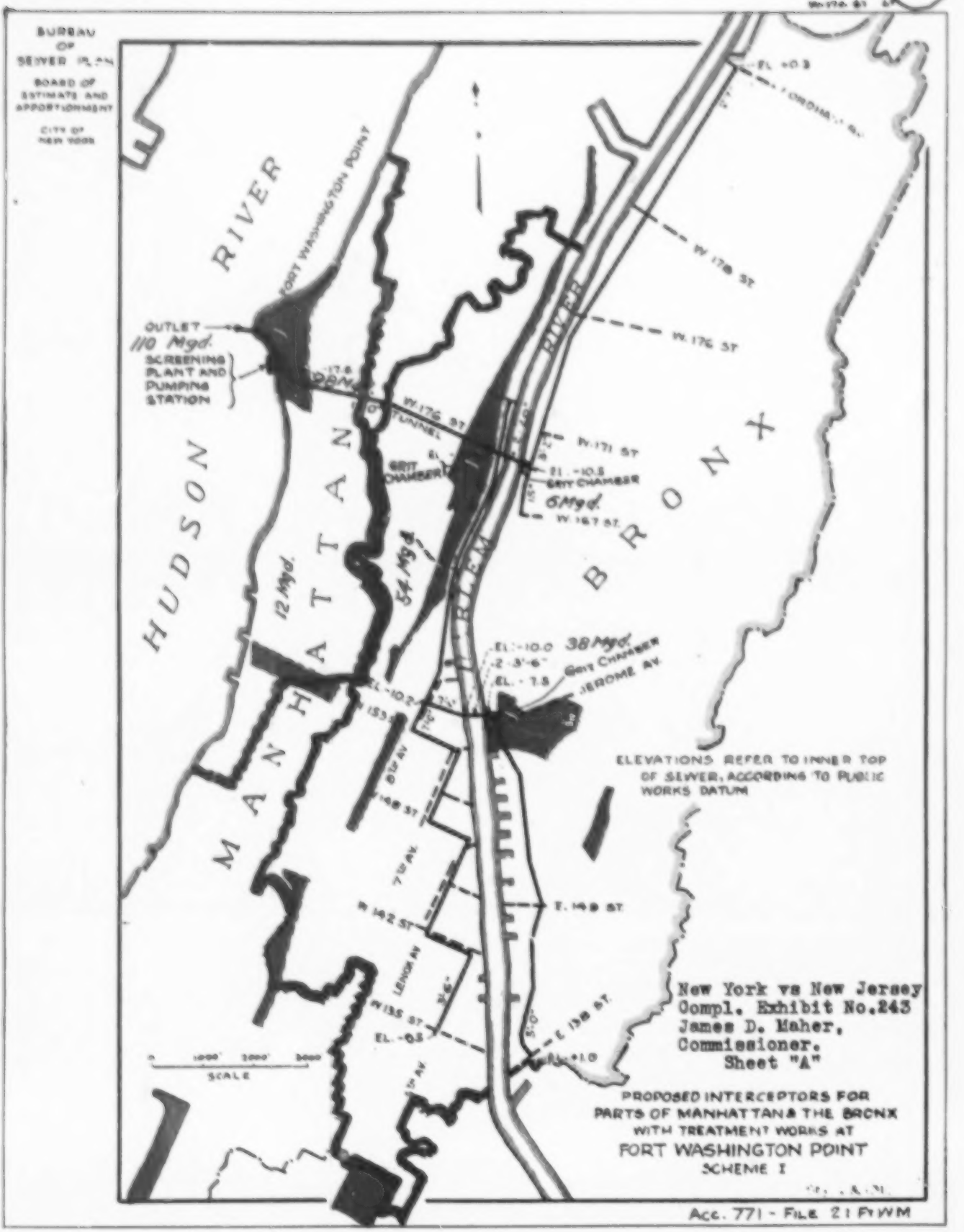
A. No.

Q. Have they been rejected in favor of the proceeding plans?
A. Yes.
Q. Were these the original plans for the disposal of the sewage of that area?
A. Yes.

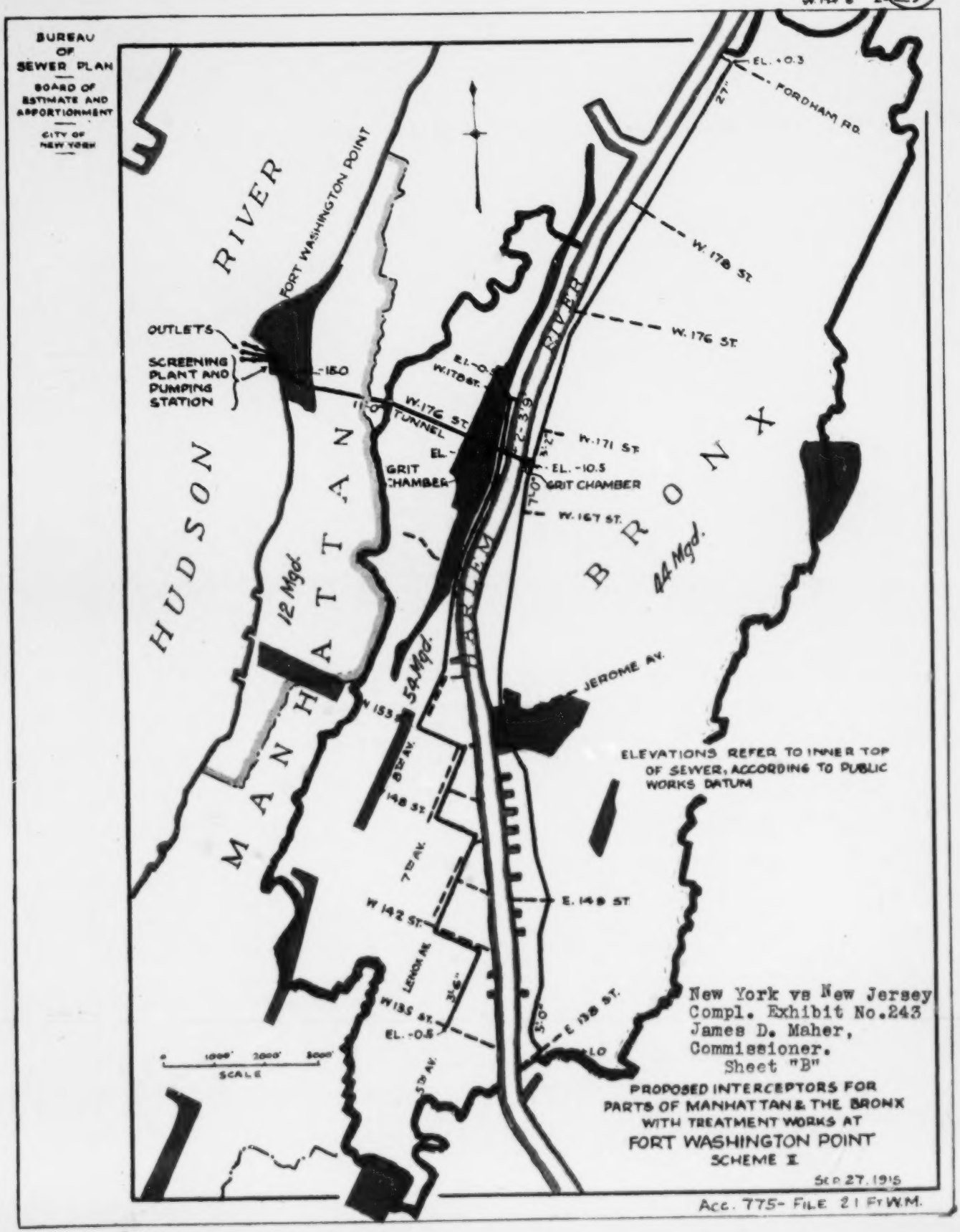
Dr. O'Sullivan: For the purpose of showing the thoroughness with which the Board of Estimate and Apportionment have approached this complex problem, I offer the plans now proposed by this witness for the proposed interceptors and discharge, after treatment of sewage at Fort Washington Point, and ask that they be marked Complainants' Exhibit 243.

By Mr. Riker:

Q. Mr. Allen, when were these plans prepared?
A. The same year that the others were, in 1915.
Q. Have they ever been presented to the Bureau of Sewer Plan?
A. Yes.
Q. Rejected?
A. Yes; they were all presented at the same time. There were three projects that I worked up, and we left them all with my recommendations with a report.
Q. Did you recommend this one?
A. I recommended the first one I presented, with the 155th Street discharge.
Q. In presenting this report to the Bureau of Sewer Plan,
751 what was your purpose, if you recommended another one?
A. It was a matter of so much importance, the extent of the work was of such importance, that I thought all sides should be presented, especially as it was to be discussed by the two Boroughs.
Q. This plan, however, is equally feasible with the one you did recommend, is it not?
A. Well, that depends on what you mean by feasible. It would be much more costly on account of the rocky formation at the point at Washington Point. It would be practical to build it, and it is only rejected on account of the great cost.
Q. Would it be more effective than the one which was actually approved?
A. No.
Q. Would it serve a larger area?
A. No.
Q. Would it be cheaper in operation?
A. No.
Q. Why did you submit it, then?
A. Because I thought the gentlemen who were studying the problem and discussing it should be in a position to know all the facts possible in the case, with the arguments for the selection.
Q. This plan as presented, involves what kind of treatment?
A. Fine screening.



Acc. 771 - File 21 FtWM

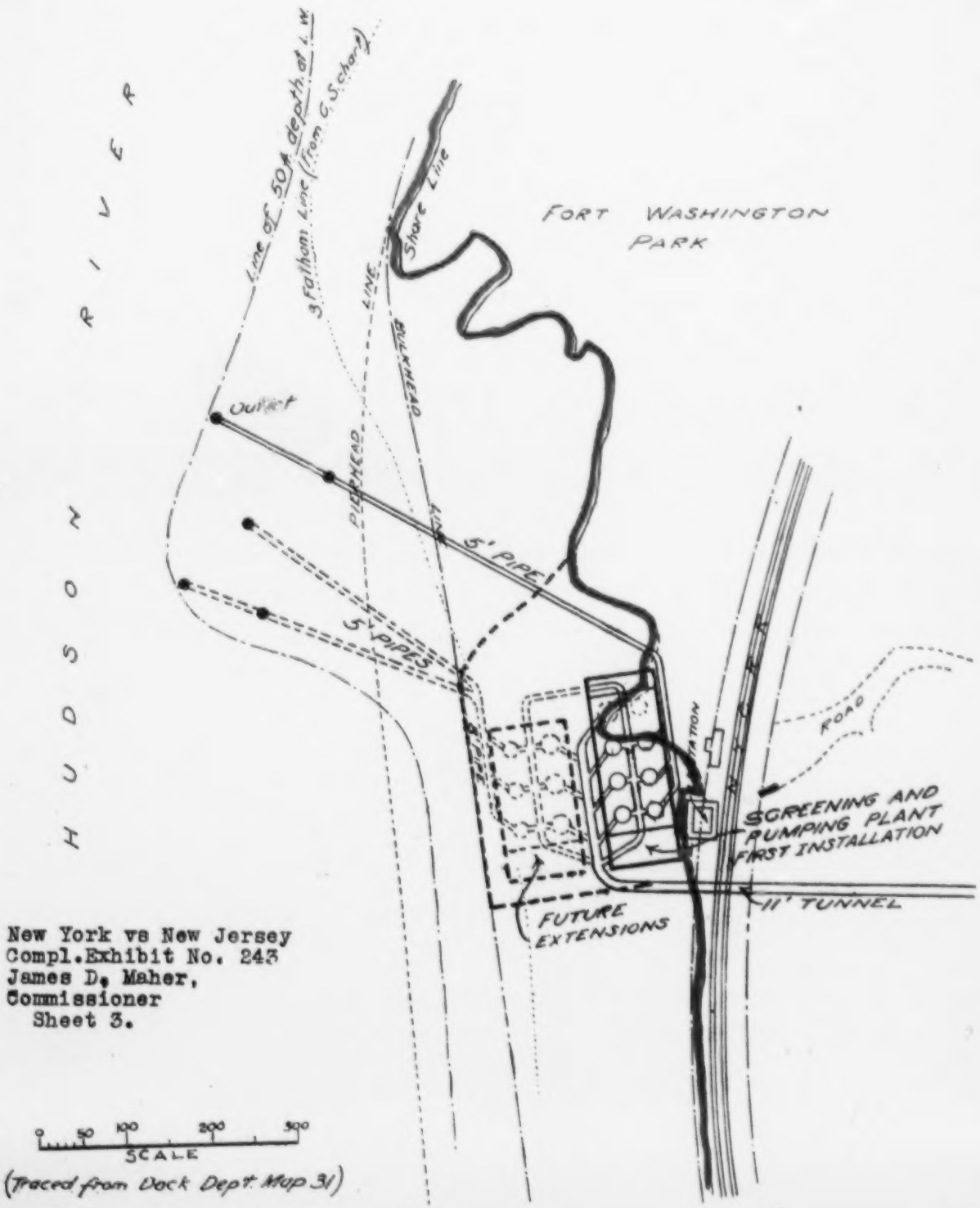

BUREAU OF SEWER PLAN
BOARD OF ESTIMATE AND APPORTIONMENT
CITY OF NEW YORK
HUDSON RIVER
FORT WASHINGTON POINT
OUTLETS
SCREENING PLANT AND PUMPING STATION
-15.0
11'-0"
W. 176 ST.
TUNNEL
EL.
GRIT CHAMBER
EL. +0.3
FORDHAM RD.
27"
W. 178 ST.
W. 176 ST.
W. 171 ST.
EL. -10.5
GRIT CHAMBER
W. 167 ST.
HARLEM RIVER
BRONX
44 Mgd.
MANHATTAN
12 Mgd.
54 Mgd.
JEROME AV.
W 153
8TH AV.
148 ST.
7TH AV.
W 142 ST.
E. 149 ST.
LENOX AV.
W 135 ST.
EL. -0.5
E 138 ST.
5TH AV.
ELEVATIONS REFER TO INNER TOP OF SEWER, ACCORDING TO PUBLIC WORKS DATUM
0 1000' 2000' 3000'
SCALE
New York vs New Jersey
Compl. Exhibit No.243
James D. Maher,
Commissioner.
Sheet "B"
PROPOSED INTERCEPTORS FOR PARTS OF MANHATTAN & THE BRONX WITH TREATMENT WORKS AT
FORT WASHINGTON POINT
SCHEME II
SEP 27. 1915
ACC. 775- FILE 21 FT W.M.

BUREAU OF SEWER PLAN
BOARD OF ESTIMATE AND APPORTIONMENT

FORT WASHINGTON POINT TREATMENT WORKS & OUTLET
GENERAL PLAN

MADE IN CONNECTION WITH Bronx Plan of April 22, 1915

FILE P. 1 Ft W M
ACC 802
COMPUTER Watt
FROM
TO
CHECKER
DATE July 17 1915



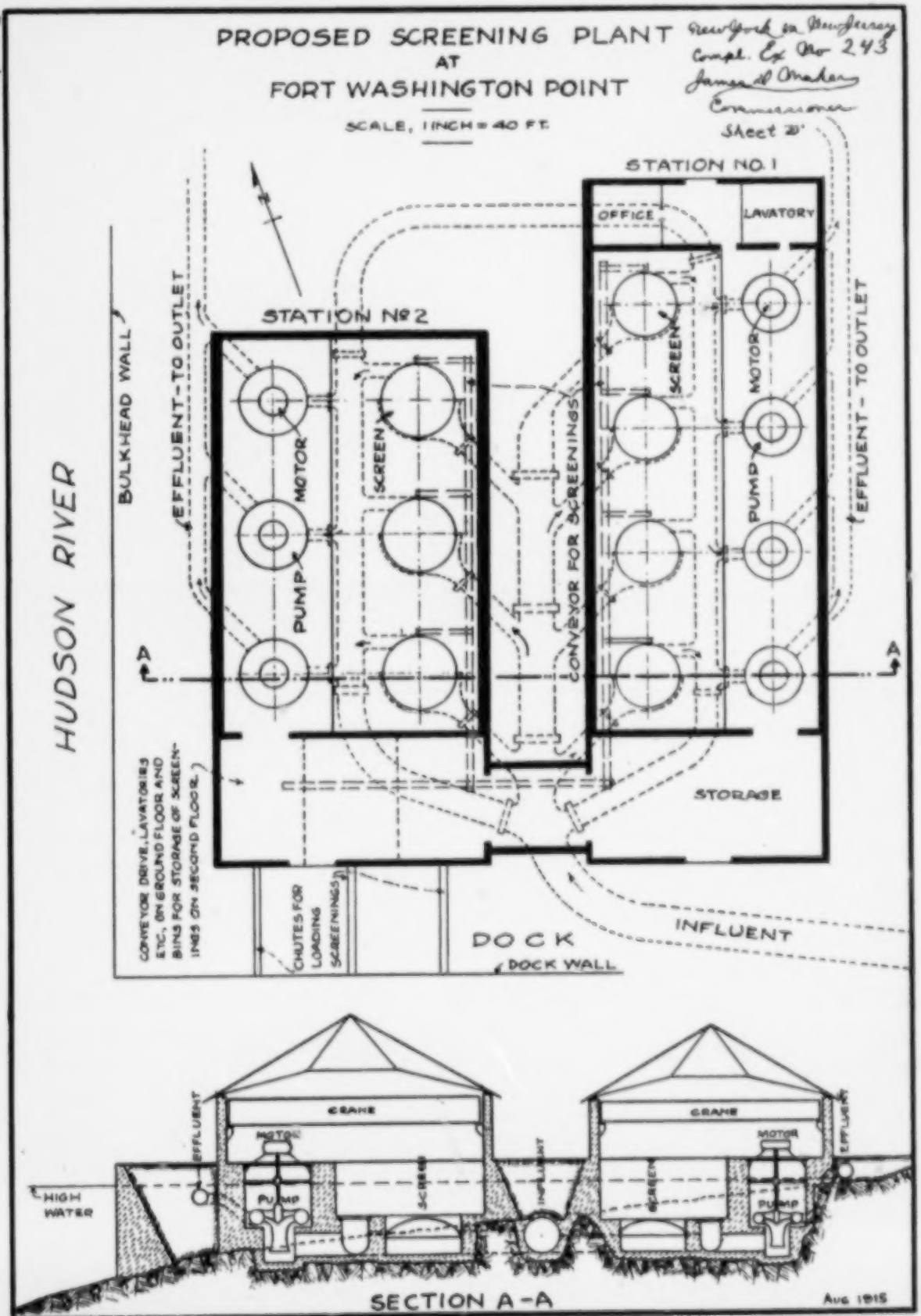
New York vs New Jersey
Compl. Exhibit No. 243
James D. Maher,
Commissioner
Sheet 3.

(Traced from Dock Dept. Map 31)

BUREAU OF SEWER PLAN

BOARD OF ESTIMATE AND APPORTIONMENT

CITY OF NEW YORK



ACC. 1125 - FILE 2.1 FT. W.M.

Q. Grit chamber treatment?
A. I think so.

Mr. Riker: No objection.

(The paper was marked Complainants' Exhibit No. 243.)

(Here follows map marked page 751a.)

By Dr. O'Sullivan:

752 Q. A little earlier in your examination, Mr. Allen, you alluded to the Dyckman Street plant. Is that now in operation?

A. Yes.

Q. Have you applied tests to determine the efficiency of that plant?

A. I have. We made very careful tests in June of this year, to see what removal had been accomplished by its operation, and without reading the entire tabulation which I present, I will say that the removal of settlable solids, which is the figure on which the efficiency of the screen is best indicated, has been as follows, on the different dates given:

June 4th, between 11:30 a. m. and 3:30 p. m., 13.3 per cent. was removed.

June 5th, from 10:15 a. m. to 2:15 p. m., 21.5 per cent.

June 12th, from 8:00 a. m. to 12:00 noon, 26.9 per cent.

June 9th, from 10:15 a. m. to 2:15 p. m., 19 per cent.; from 2:15 p. m. to 6:15 p. m., 58.9 per cent.; from 6:15 p. m. to 10:15 p. m., 46.8 per cent.; from 10:15 p. m. to 2:15 a. m., 35.8 per cent.; from 2:15 a. m. to 6:15 a. m., 92.5 per cent.

June 10th, from 6:15 a. m. to 10:15 a. m., 54.8 per cent.

The tests that I have read were made on a screen 14 feet deep in diameter, having slots three-sixty-fourths of an inch wide.

Q. What type of screen?

A. Rienach-Wurl screen, with the axis inclined 20 de-
753 grees from the vertical. Following those tests, the further tests were made of a similar screen having slots 1/16 of an inch in size.

June 16th, from 10.45 a. m. to 2.45 p. m. there was removed 12.7 per cent of settlable solids.

June 18th, from 10.00 a. m. to 2.00 p. m., there was removed 33.9 per cent; from 2.00 p. m. to 6.00 p. m., 18.8 per cent; from 6.00 p. m. to 10.00 p. m., 23.9 per cent; from 10.00 p. m. to 2.00 a. m., June 19th, 17.8 per cent; from 2.00 a. m. to 6.00 p. m., 14.3 per cent, and from 6.00 a. m. to 10.00 a. m., 31.1 per cent.

Q. Have you got the tables from which you have just selected results, now, with you?

A. I have.

Dr. O'Sullivan: I offer these tables in evidence and ask that they be marked Complainants' Exhibit No. 244.

By Mr. Riker:

Q. Who prepared these tables, Mr. Allen?

A. I did.

Q. Where did you get the data from?

A. The data was secured by the chemist, Mr. Carpenter. A part of the time I was at the plant during the tests and took some of the data myself, and in the night shift, one of the employees—the man

TEST OF RIENSCH-WURL SCREEN NO. 1 File S.7222 W-DYCK

DYCKMAN ST. MANHATTAN Aug 2274

Made in connection with Aug. 2266, 2273, 2267, 2270, 2275. Checked W.T.C. Date June 4, 5&12, 1919

Computer K.A. From to

DATE	JUNE 4	JUNE 5	JUNE 12
TIME	11.30 A.M.-3.30 P.M	10.15 A.M.-2.15 P.M	8.00 A.M.-12.00 M.
Sewage Flow			
Volume GAL.	241 800	337 560	375 550
Rate MGD	2.052	2.025	2.253
Analytical Results			
Raw Sewage			
Susp. Solids PPM	129	185	244
Volatile "	105	143	160
Ash "	24	42	84
Settleables "	129	165	164
Volatile "	105	123	92
Ash "	24	42	72
Screened Sewage			
Susp. Solids PPM	112	150	200
Volatile "	90	111	120
Ash "	22	39	80
Settleables "	112	130	120
Volatile "	90	91	52
Ash "	22	39	68
Screenings			
Rem'd by screen PPM	17.2	35.6	44
Moisture %	80.4	70.2	84.0
Dry Material %	19.6	29.8	16.0
Ash (dry basis) %	10.0	9.7	9.5
Volume CU.FT.	4.55	- -	15.36
" PER MG "	13.35	- -	40.91
Weight LBS	249	335	859
" PER MG "	729	993	2287
" " CU.FT. "	54.7	- -	55.9
Power Consumed KWH	20 (For flow 31397 CuFt)	28	31
" " PER MG "	85	83	83
Head Lost - Average FT.	.225	.215	.39
Removal of Suspended Matter %	13.3	19.2	18.1
" " Settleable Solids %	13.3	21.5	26.9

Complainants Exhibit No 244
Sheet A.

TEST OF RIENSCH-WURL SCREEN NO. 1 File 3.7222 M-DYCK

DYCKMAN ST. MANHATTAN Acc 2275

Made in Computer K.A. From to
connection with Acc 2266, 2267, 2270, 2273, 2274. Checked W.F.C. Date June 9 & 10 1919

DATE		JUNE 9			JUNE 9-10	JUNE 10	
TIME		10.15 AM. to 2.15 PM.	2.15 PM. to 6.15 PM.	6.15 PM. to 10.15 PM	10.15 PM. to 2.15 AM.	2.15 AM. to 6.15 AM.	6.15 AM. to 10.15 AM
		(Shower 12-1230)	(Light shower at 2.45)				
Sewage Flow							
Volume	GAL.	384 600	269 300	285 600	230 200	166 100	350 900
Rate	MGD	2.308	1.616	1.714	1.381	0.997	2.105
Analytical Results							
Raw Sewage							
Susp. Solids	PPM	276	84	86	53	40	168
Volatile	"	179	76	79	50	34	142
Ash	"	97	8	7	3	6	26
Settleable Sol.	"	226	41	56	53	40	106
Volatile	"	143	33	49	50	34	92
Ash	"	83	8	7	3	6	14
Screened Sewage							
Susp. Solids	"	233	60	60	34	3	110
Volatile	"	146	55	55	34	3	90
Ash	"	87	5	5	0	0	20
Settleable Sol.	"	183	17	30	34	3	48
Volatile	"	110	12	25	34	3	40
Ash	"	73	5	5	0	0	8
Screenings							
Removed by SCR.	PPM	43	24	26	19	37	58
Moisture	%	78.7	75.9	79.4	76.1	79.8	78.4
Dry Material	%	21.3	24.1	20.6	23.9	20.2	21.6
Ash (Dry basis)	%	22.2	13.5	6.6	16.5	15.2	9.7
Volume	CU.FT	11.16	4.52	5.28	3.11	0.66	13.59
" PER MG	"	29.02	16.8	18.4	13.5	4.0	28.7
Weight	LBS	644	226	303 ½	152	25	781 ½
" PER MG	"	1675	839	1063	660	151	2227
" " CU.FT	"	57.7	50.0	57.4	48.9	37.9	57.5
Power Consumed	KWH	36	28	26	27	29	27
" " PER MG	"	94	104	91	117	175	77
Head Lost - Average	FT	0.25	0.16	0.12	0.08	0.07	0.29
Removal of Suspended Matter	%	15.6	29.0	30.6	35.8	92.5	34.6
" " Settleable Solids	%	19.0	58.9	46.8	35.8	92.5	54.8

Complainants Exhibit No 244
Sheet B.

TEST OF RIENSCH-WURL SCREEN NO. 2 File 3.7222 M-DYCK

DYCKMAN ST. MANHATTAN Acc 2280

Computer K.A. From to

Made in connection with Acc 2276, 2277, 2278, 2279, 2281. Checker W.T.C. Date June 16 1919

DATE		JUNE 16, 1919.
TIME		10.45 A.M. - 2.45 P.M.
Sewage Flow		
Volume	GAL	349 500
Rate	MGD	2.097
Analytical Results		
Raw Sewage		
Suspended Solids	PPM	175
Volatile	"	144
Ash	"	31
Settleable Solids	"	118
Volatile	"	87
Ash	"	31
Screened Sewage		
Suspended Solids	PPM	160
Volatile	"	131
Ash	"	29
Settleable Solids	"	103
Volatile	"	74
Ash	"	29
Screenings		
Removed by Screen	PPM	15
Moisture	%	85.9
Dry Material	%	14.1
Ash (Dry basis)	%	10.6
Volume	CU.FT	5.63
" PER MG	"	16.1
Weight	LBS	309
" PER MG	"	885
" " CU.FT	"	54.9
Power Consumed	KWH	33
" " PER MG	"	94
Head Lost - Average	FT	.015
Removal of Suspended Matter	%	8.6
" " Settleable Solids	%	12.7

Complainants Exhibit No 244
Sheet C.

TEST OF RIENSCH-WURL SCREEN NO. 2 File 3.7222 M-DYCK

DYCKMAN ST. MANHATTAN Acc 2281

Computer K.A. From to

Made in connection with Acc 2276, 2277, 2278, 2279, 2280. Checker W.T.C. Date June 18-19 1919

DATE		JUNE 18			JUNE 18-19	JUNE 19	
TIME		10.00 AM. to 2.00 PM.	2.00 PM. to 6.00 PM.	6.00 PM. to 10.00 PM	10.00 PM. to 2.00 AM.	2.00 AM. to 6.00 AM.	6.00 AM to 10.00 AM
Sewage Flow							
Volume	GAL.	326 400	268 300	273 100	230 100	156 700	299 900
Rate	MGD	1.958	1.610	1.639	1.380	0.940	1.799
Analytical Results							
Raw Sewage							
Susp. Solids	PPM	139	113	122	73	28	197
Volatile	"	91	76	91	56	28	147
Ash	"	48	37	31	17	0	50
Settleable Sol.	"	62	69	92	73	28	119
Volatile	"	21	46	76	56	28	80
Ash	"	41	23	16	17	0	39
Screened Sewage							
Susp. Solids	PPM	118	100	100	60	24	160
Volatile	"	72	64	70	44	24	114
Ash	"	46	36	30	16	0	46
Settleable Sol.	"	41	56	70	60	24	82
Volatile	"	2	34	55	44	24	47
Ash	"	39	22	15	16	0	35
Screenings							
Rem'd by Screen	PPM	21	13	22	13	4	37
Moisture	%	79.7	81.0	79.5	82.4	84.3	84.4
Dry Material	%	20.3	19.0	20.5	17.6	15.7	15.6
Ash (Dry basis)	%	10.1	8.1	6.7	7.7	11.2	10.2
Volume	CU.FT	5.18	2.76	4.55	2.89	0.66	9.84
" PER MG	"	15.9	10.3	16.7	12.6	4.21	32.8
Weight	LBS	283	148	244	137	36	593
" PER MG	"	868	552	893	595	230	1977
" " CU.FT	"	54.6	53.6	53.6	47.4	54.5	60.3
Power Consumed	KWH	32	36	31	32	28	28
" " PER MG	"	98	135	114	139	178	93
Head Lost - Average	FT	.018	.012	.027	.015	.041	.031
Removal of Suspended Matter	%	15.1	11.5	18.0	17.8	14.3	18.8
" " Settleable Solids	%	33.9	18.8	23.9	17.8	14.3	31.1

NEW YORK vs NEW JERSEY
Complainants Exhibit No 244
JAMES D. MAHER
Commissioner
Sheet D.

in charge of the station—took the samples for Mr. Carpenter.

Q. Can you pick out from this table the results, based on the data secured by yourself?

A. All the figures here were obtained by the analyses made
754 by Mr. Carpenter, with the exception of the volume of flow of sewage, and the head lost in passing the screen. Those were obtained from reading the gauges which we had on the work, and the only work I did was to read those gauges at certain times. I was present at every test, nearly all the tests, except the 24-hour test, when I was only there a few hours. In the test of June 4th to June 5th, and June 12th, I read the float gauge, which indicated the height of water below the screen, and the board gauge, which read the height of water above the screen, and the watt meter, which measured the current of electricity that was required.

Q. In determining the percentage of removal of solids, however, you had no actual part, did you?

A. Except in the computation. I made computations from the results of analyses in the laboratory.

Q. You had nothing to do with the analyses?

A. No.

Q. You do not know whether they were correct or not?

A. I know that they were correct.

Q. How do you know?

A. Because Mr. Carpenter is a reputable engineer who has had a large experience.

Q. You know it because you believe it, is it not so?

A. What is that?

Q. You know it because you believe it, is it not so?

A. That is all we can say of anyone that does work we do
755 not do ourselves.

Q. These tests were made in June of this year?

A. Yes.

Q. Where is Mr. Carpenter?

A. I think he is in this building.

Q. He was here yesterday morning, was he not?

A. Yes.

Q. Where is the tracing from which this blueprint was taken?

A. In my office.

Mr. Riker: No objection.

(The paper was received and marked Complainants' Exhibit No. 244.)

(Here follows table marked page 755*a*.)

By Dr. O'Sullivan:

Q. Mr. Allen, have you got any photographs of either the Rienach-Wurl screen or other device in the interior of the Dyckman Street plant?

A. I have. I have here three views which I took myself, to give a little idea of the interior of the plant. This view shows one corner of the building, the screens being below the floor. It merely gives a general view. The second one was taken to show the automatic recording apparatus, which is operated by a float, and indicates the elevation of the water, after having passed through the screen. The device is shown as a cylinder inside of a glass box. The third view shows the screen itself while in operation, and just beyond the screen is the board gauge indicating the elevation of the incoming water, the sewage. I also have a cut taken from the catalogue of the Sanitation Corporation, who manufacture these screns, to show
756 the general shape of the screen, before erected in place.

Dr. O'Sullivan: I offer these three photographs and the cut in evidence, and ask that they be marked Complainants' Exhibit No. 245.

By Mr. Riker:

Q. The cut, Mr. Allen, which you have produced here, purports to be a cut of a screen with the sewage treatment plan of the city of Dresden?

A. Yes.

Q. You do not happen to know whether such a thing does exist, of your own knowledge?

A. I do.

Q. Have you seen it?

A. In 1913.

Q. In Dresden?

A. Yes.

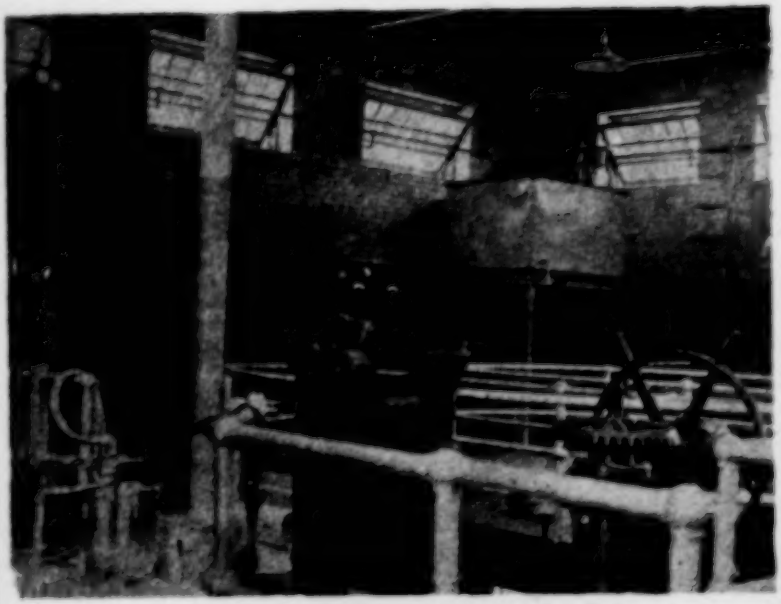
Q. And you say that is a correct representation of it?

A. So far as I can tell, similar to that. I also went to the factory where they manufacture them, just outside Berlin.

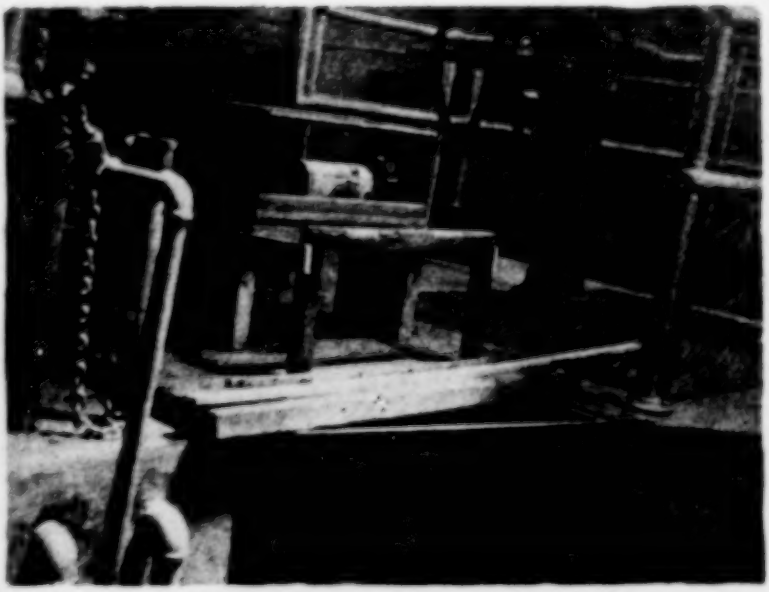
Mr. Riker: No objection.

(The photographs were received in evidence and marked Complainants' Exhibit No. 245.)

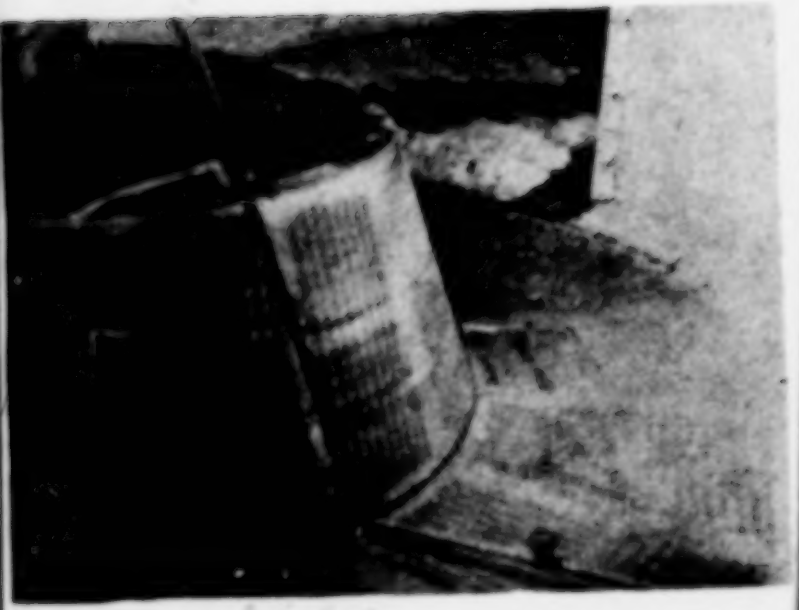
(Here follow photographs marked page 756a.)



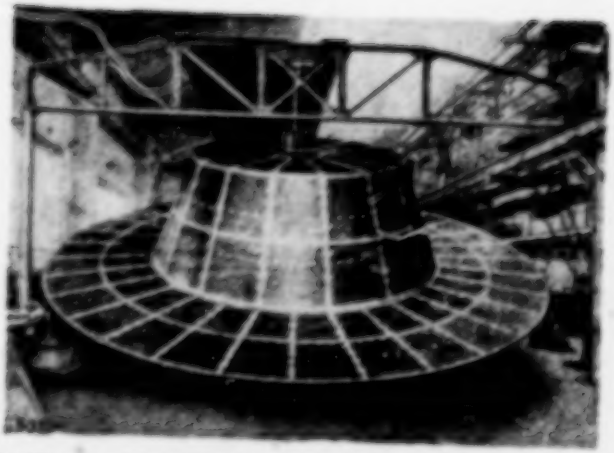
New York vs New Jersey
Compl. Exhibit No 245
James D. Maher
Commissioner
Sheet 1



New York vs New Jersey
Compl.Exhibit No.245
James D. Maher
Commissioner
Sheet 2



New York vs New Jersey
Compl. Exhibit No. 245
James D. Maher
Commissioner
Sheet 3



Cut 35. One of the Four Rienech-Wurl Separator Screens, 26 Feet in Diameter, on the Erecting Frame at the Factory—for the Sewage Treatment Plant of the City of Dresden

New York vs New Jersey
Compl.Exhibit No.245
James D. Maher,
Commissioner
Sheet 4

INDEX TO VOLUME II.

ADDITIONAL TESTIMONY.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1920.

No. 2, Original.

THE PEOPLE OF THE STATE OF NEW YORK, COMPLAINANTS,

vs.

THE STATE OF NEW JERSEY AND PASSAIC VALLEY SEWERAGE COMMISSIONERS.

IN EQUITY.

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JUDD & DETWEILER (INC.), PRINTERS, WASHINGTON, D. C., JUNE 23, 1920.

	Original.	Print.
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By Dr. O'Sullivan:

Q. A little earlier in your testimony, Mr. Allen, you mentioned sewage disposal systems that would extend to Ward's Island, Randall's Island and Riker's Island, and for alternating schemes of disposal. Have you prepared any designs for interceptors with treatment works at Wards and at Riker's Island?

A. I have. This map shows the results of the study made
757 for that purpose.

Q. And these designs are now under consideration?

A. They are. The plan indicates two series of interceptors, one leading to Brook Avenue, from which a tunnel would take the sewage to Ward's Island, and the other leading to the foot of Manida Street in the Bronx, with a tunnel to Riker's Island, and the disposal plant is shown on each plan. With regard to the first project, the Borough engineers at first proposed the taking of the sewage to Riker's Island, and no conclusion was arrived at as to the final distribution of the sewage intercepted, but it was decided to carry that sewage to the foot of East 132nd Street, where there will be a temporary disposal plant, from which point it can be taken to Ward's Island, just as readily as from Brook Avenue, or it can be diverted to Riker's Island, if thought best at that time. The other sewage carried by the interceptor at the foot of the page, will go to Riker's Island.

Dr. O'Sullivan: I offer the designs just described by this witness for a disposal system at Riker's Island, and for a disposal system at Ward's Island, and ask that it be marked Complainants' Exhibit 246.

By Mr. Riker:

Q. This paper has the date at the foot of it, November, 1915; is that the date of its preparation?

A. Yes.

Q. Was it prepared by you?

A. Yes.

758 Q. Submitted to the Bureau of Sewer Plan, was it?

A. Yes.

Q. Adopted by that Bureau?

A. I do not remember whether it was adopted formally by that Bureau, but the part that has been adopted is the interception of the western part. The lines of interception from 3rd Avenue to East 138th Street have been officially adopted.

Q. When you say that part has been officially adopted, what do you mean?

A. I mean that that has been adopted by the Board of Estimate, and placed on file as an official drainage plan.

Q. And did they advertise for bids?

A. No, they have not been constructed.

Q. Are they ordered to be constructed?

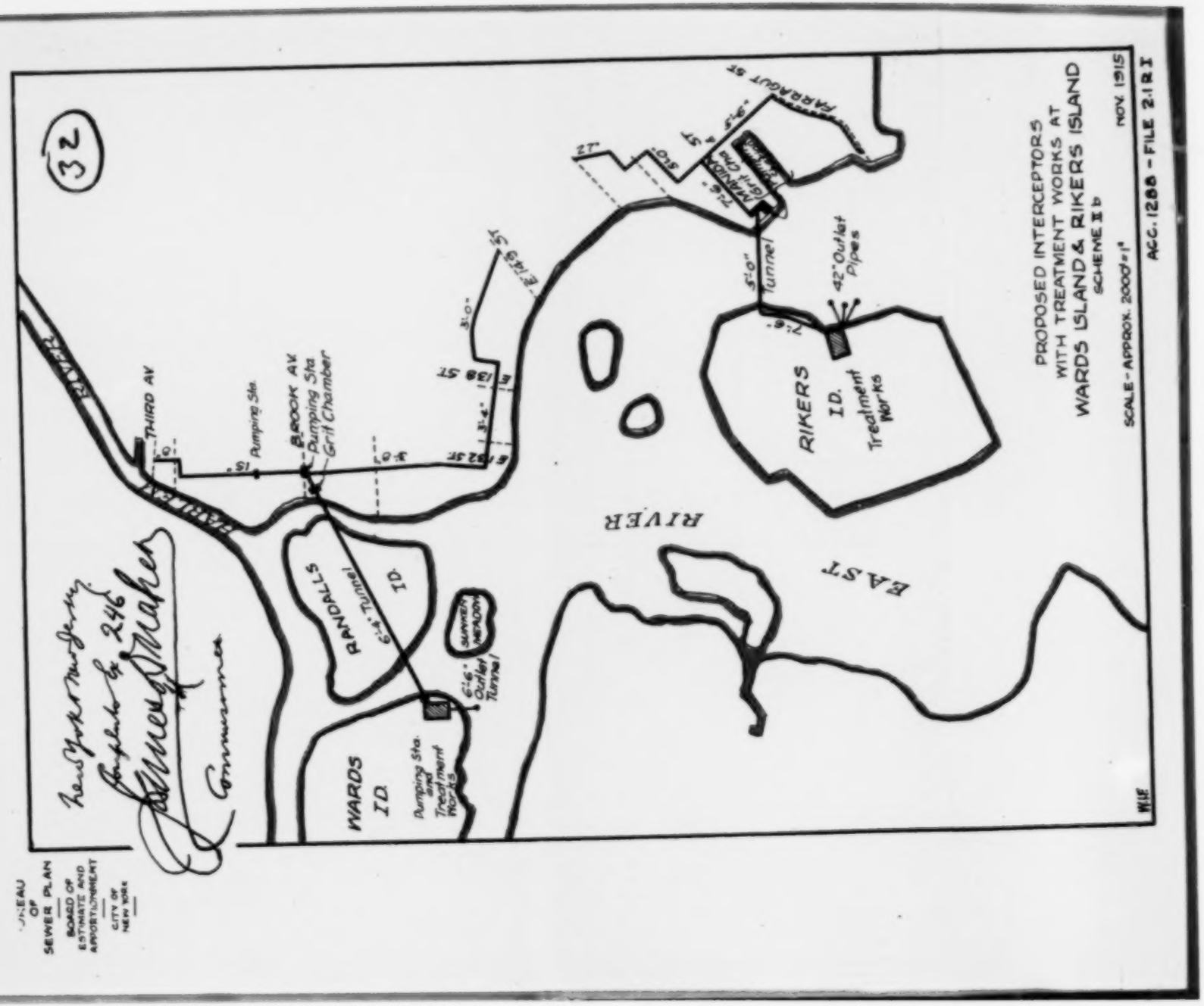
A. I think not.

Q. This plan that you present now, was intended by you to relieve these areas of objectionable pollution, was it not?
A. Yes.
Q. And you believe it to be efficient for that purpose, if put into operation?
A. Yes.
Q. Do you know the population—is there any indicated population on this plan?
A. I do not think there is. I do not have that with me, but I have it downstairs.
Q. You do not know what it is, from memory?
A. Not from memory, no.
Q. Do you know what the plan does indicate, what volume
759 of sewage is provided for?
A. No.
Q. You do not rememeber?
A. No.
Q. Approximately, can you state?
A. I should say about sixty million gallons to Ward's Island, but I would not like to be sure of that without referring to my notes.
Q. Are there two separate areas indicated for treatment in this plan?
A. Yes.
Q. Have you any alternative plan for this particular area?
A. No; except as to treatment. The treatment intended at those points is sedimentation; but it is possible that a higher degree of treatment may be required in time at Ward's Island.
Q. How much higher?
A. I could not say that.
Q. Is this plan designed to cover the period up to 1960?
A. Yes.

Mr. Riker: No objection.

(The paper was received in evidence and marked Complainants' Exhibit No. 246.)

(Here follows diagram marked page 759a.)



By Dr. O'Sullivan:

Q. Mr. Allen, did you complete the designs for interceptors and for sewage disposal for the sewage to be collected and treated at East 49th Street?

A. I did. That is, I made a study and a tentative design for a plant at that point. This is indicated on the print as a series of tanks, with the outlet discharging beyond the pierhead line. The area available is barely sufficient for the purpose.
760 Beekman Place and East 50th Street, with this improved property in the northwest corner, lie at a much higher elevation than the rest. The site of the plant has been excavated in the rock down to about street level, and would answer the purpose of a plant of that kind.

Dr. O'Sullivan: I offer the design for interceptors and sewage treatment just described by the witness for East 49th Street, and ask that it be marked Complainants' Exhibit 247.

By Mr. Riker:

Q. Did you prepare this plan?

A. Yes.

Q. In October, 1915?

A. Yes.

Q. If you prepared it, why did you approve of it?

A. Yes. Why did I approve it?

Q. Yes; it seems to be your approval for signature.

A. The plans that are prepared by me and are filed as the approved plans, are usually signed by me in that way; we make various plans, and those are the ones selected and approved.

Q. Has this been adopted by the Board of Sewer Plan?

A. No.

Q. Adopted by any other body?

A. No.

Q. It is simply a plan that you have prepared and have submitted?

A. Yes, but it has been verbally approved by the Engineer of the Sewer Bureau of Manhattan. That is not an official
761 action.

Q. He agrees with you with reference to the plan, that was all?

A. Yes.

Q. Was this plan devised to cover a period up to 1960?

A. Yes.

Q. It appears to involve some species of tank; is that a septic tank?

A. No.

Q. What kind of tank?

A. Dortmund.

Q. Is that the name of the inventor of it?

A. No; it is the name of the town in Germany where that general type was first used, only it is not the same as the tank that was used there, but the operation is similar, and that was the generic name for that type of tank.

Q. I notice that the offer contains a description of the proposed Emscher tank?

A. I take back what I say. That is an Emscher tank.

Q. And is that a septic tank plant?

A. It is in reality a form of septic, but not septic tank, and called an Emscher tank, or an Imhoff tank.

Q. Is that all the treatment that is proposed by this plan?

A. Yes.

Q. Does this offer indicate the complete plans for treatment and discharge?

A. It does not show the submerged outlet.

Q. Is not that involved in the plan?

A. Yes.

762 Q. Submerged to what depth?

A. Not less than forty feet.

Q. And at the pierhead or beyond?

A. Beyond the pierhead.

Q. This has been filed with you by the proper Board or body, has it not, this plan?

A. It has been filed with a report with the Chief Engineer.

Q. Do you know why it has not been acted on?

A. Yes, the Bureau has never brought forward a plan for adoption. I might explain that before any plan is adopted, a drainage plan is presented by the Bureau to the Board for adoption; so the Bureau takes the initiative, and nothing is done beyond tentative studies by the Board of Estimate of plans until the Bureau has presented its plan.

Q. Does the plan indicate the area to be served?

A. This plan does not. I have a plan showing the area.

Q. Can you point out on the plan any indication of the quantity of sewage to be treated by this work?

A. 19.2 million gallons a day mean dry weather flow.

Q. And does it indicate the period of detention in the tanks?

A. I do not think it does.

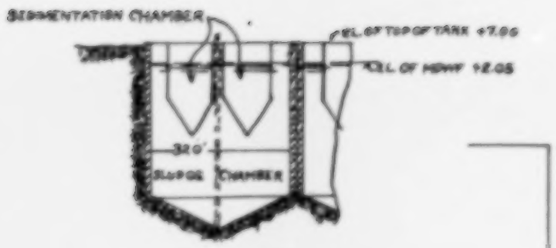
Q. What is the period of detention indicated?

A. I think it was an hour and a half.

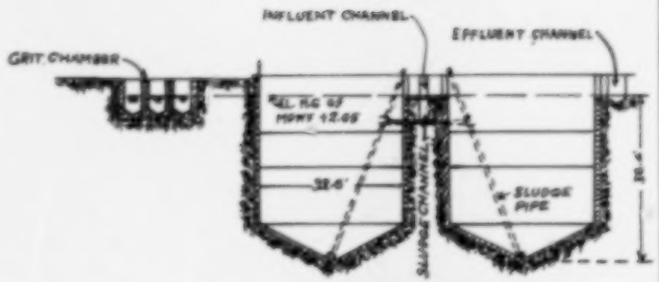
Q. How do these tanks differ from sedimentation tanks?

A. They have a partition shown in the upper left-hand sketch, between the upper and lower parts of the tank. The sewage flows through the upper two channels, the sludge falling through

763 a slot in the lower part into the sludge chamber. That keeps the sewage fresh and uncontaminated by the gases arising from the sludge, which pass up outside the sewage chambers into the air.



SECTION B-B



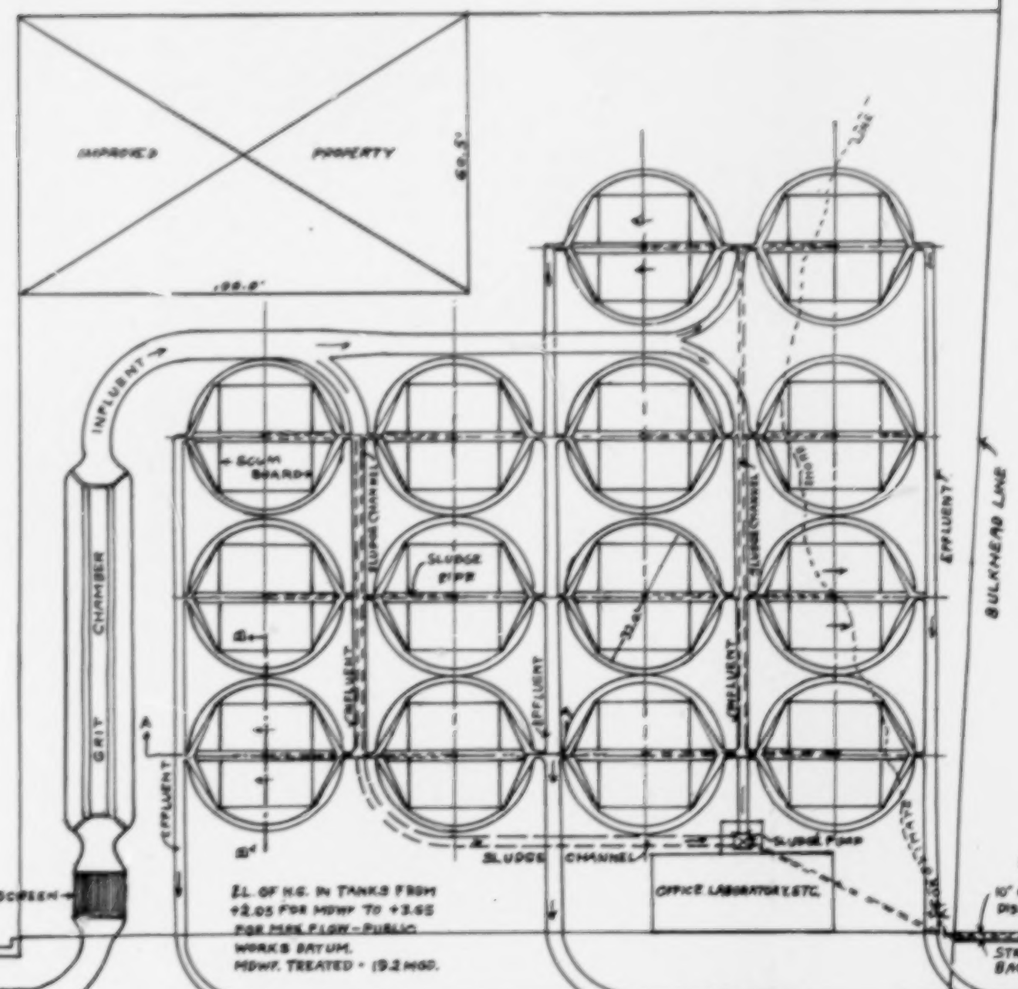
SECTION A-A

AVENUE

BEEKMAN PLACE

EAST 50TH STREET

RIVER



MITCHELL PLACE

RETAINING WALL

INFLUENT

WEIR - EL OF CREST +5.25

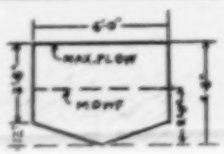
MANHOLE

STORM WATER OUTLET - (EXISTING 90"X58"-6" SEWER)

EAST 49TH STREET

EAST

FIRST



New York vs New Jersey
Complainants Exhibit No. 247
Dannie D. Maher

CITY OF NEW YORK
BOARD OF ESTIMATE & APPORTIONMENT
BUREAU OF SEWER PLAN
PROPOSED EMSCHER TANK PLANT

Vol. II

ADDITIONAL TESTIMONY

THE COURT OF THE UNITED STATES

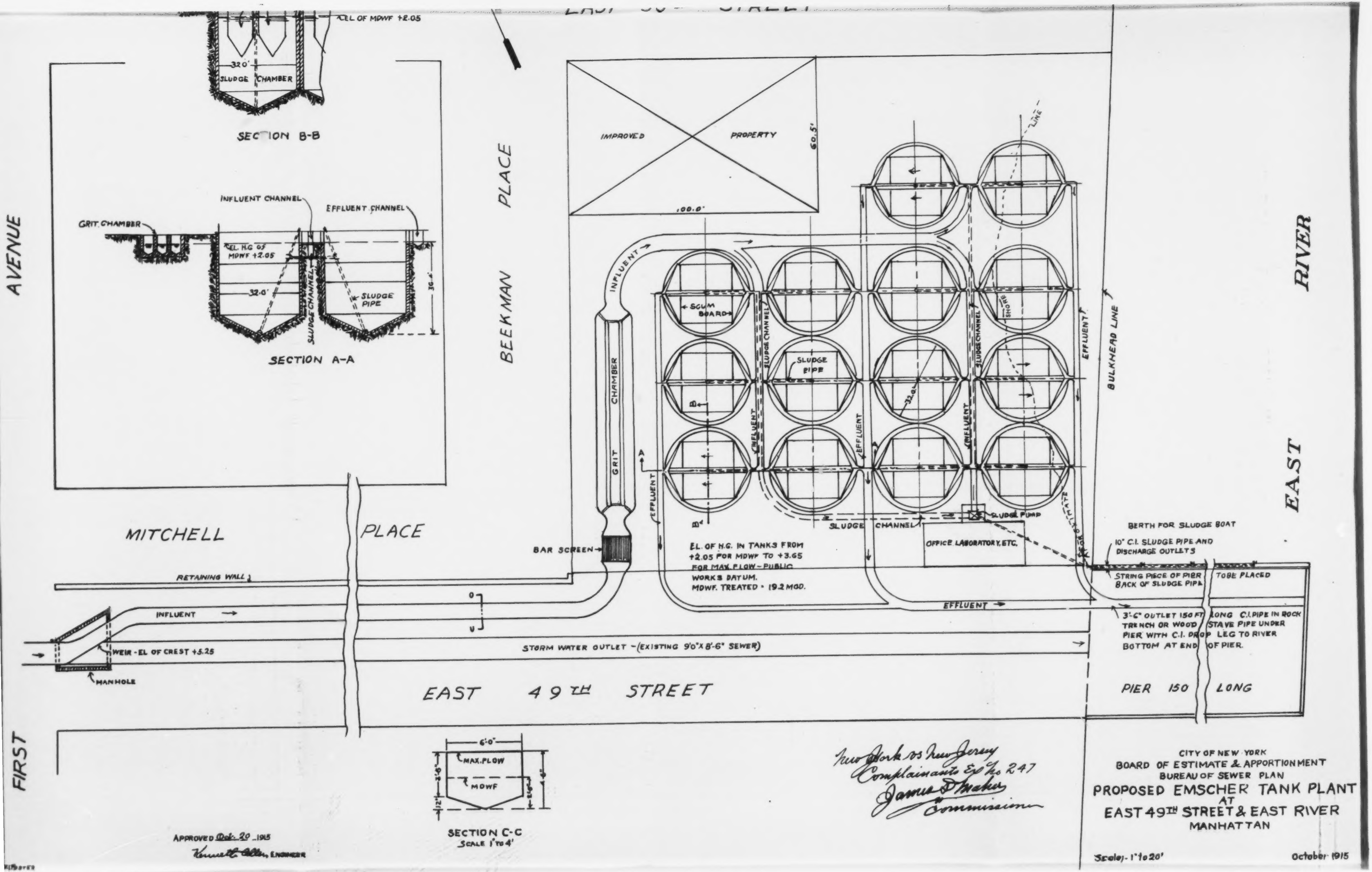
OCTOBER TERM, [illegible]

No. 2, Original.

PEOPLE OF THE STATE OF NEW YORK,
COMPLAINANTS,

vs.

[illegible] OF NEW JERSEY AND PASSAIC VALLEY
SEWERAGE COMMISSIONERS.



EL OF MDWF +2.05
32.0'
SLUDGE CHAMBER
SECTION B-B
INFLUENT CHANNEL
EFFLUENT CHANNEL
GRIT CHAMBER
EL. H.G. OF MDWF +2.05
32.0'
SLUDGE CHANNEL
SLUDGE PIPE
36.4'
SECTION A-A
AVENUE
BEEKMAN PLACE
IMPROVED PROPERTY
60.5'
100.0'
INFLUENT
GRIT CHAMBER
SCUM BOARD
SLUDGE CHANNEL
SLUDGE PIPE
INFLUENT
EFFLUENT
SHORE
EFFLUENT
BULKHEAD LINE
EAST RIVER
SLUDGE PUMP
SLUDGE CHANNEL
OFFICE LABORATORY, ETC.
BAR SCREEN
EL. OF H.G. IN TANKS FROM +2.05 FOR MDWF TO +3.65 FOR MAX. FLOW - PUBLIC WORKS DATUM.
MDWF. TREATED = 19.2 MGD.
BERTH FOR SLUDGE BOAT
10" C.I. SLUDGE PIPE AND DISCHARGE OUTLETS
STRING PIECE OF PIER BACK OF SLUDGE PIPE
TO BE PLACED
3'-6" OUTLET 150 FT LONG C.I. PIPE IN ROCK TRENCH OR WOOD STAVE PIPE UNDER PIER WITH C.I. DROP LEG TO RIVER BOTTOM AT END OF PIER.
MITCHELL PLACE
RETAINING WALL
INFLUENT
WEIR - EL OF CREST +5.25
MANHOLE
STORM WATER OUTLET - (EXISTING 9'0" X 8'-6" SEWER)
EAST 49TH STREET
PIER 150 LONG
FIRST
6'-0"
MAX. FLOW
MDWF
SECTION C-C
SCALE 1" TO 4'
New York vs New Jersey
Complainants Ex No 247
James D Maher
Commissioner
CITY OF NEW YORK
BOARD OF ESTIMATE & APPORTIONMENT
BUREAU OF SEWER PLAN
PROPOSED EMSCHER TANK PLANT
AT
EAST 49TH STREET & EAST RIVER
MANHATTAN
APPROVED Oct. 20 1915
ENGINEER
Scale - 1" to 20'
October 1915

Q. But so far as the removal is concerned, it is merely a sedimentation tank, is it not?

A. Yes.

Mr. Riker: No objection.

(The paper was received in evidence and marked Complainants' Exhibit No. 247.)

(Here follows drawing marked page 763*a*.)

By Dr. O'Sullivan:

Q. Mr. Allen, did you, in the course of your official duties, as Sanitary Engineer of the Board of Estimate and Apportionment of this City, submit a report to Mr. Nelson P. Lewis, the Chief Engineer of the Board of Estimate and Apportionment, in relation to the disposal through an ocean Island project?

A. I did. The whole question of sewage disposal of New York City depends very largely on what is done with the sewage of the Harlem River, and the Lower East River and Brooklyn. The sketch at the end of this report indicates the plan recommended by the Metropolitan Sewerage Commission, collecting the sewage from the Harlem River to Ward's Island, and that from the lower part of the East River and the opposite shore of Brooklyn, to a point near the Navy Yard, from which it will be pumped through a tunnel to an island built about three miles south of Coney Island, an artificial island. The sewage from Jamaica and from
764 Brooklyn, tributary to Jamaica Bay and Gravesend Bay, and that from Coney Island, would be diverted to the same tunnel for disposal. The Sewer Plan Commission, which was in existence in 1914, presented an alternate plan, proposing a discharge of the sewage from the Lower East River to a point off Red Hook, south of Governor's Island. This report is to produce the comparative estimates of these two general projects. The ocean island project, including the care of the sewage entering the Harlem River and including as both estimates do, the cost of several isolated plants, in the Lower East River, is estimated at $31,146,000, and the gross annual charges including sinking fund and interest would be $2,646,300. The other project, with the disposal at Red Hook, an island off Red Hook Point, is estimated at $24,154,000, and the gross annual charges at $2,218,900, indicating the latter to be a more economical project.

By Mr. McCarter:

Q. That is the Red Hook?

A. Yes. But the feasibility of permitting the discharge of so large a volume of sewage into the Upper Bay depends very largely on the condition of the Upper Bay, and the discharge of sewage from the Passaic Valley into it. The difference in the cost is about seven million dollars.

765 Dr. O'Sullivan: I offer the report just described by this witness in evidence, and ask that it be marked Complainants' Exhibit 248.

By Mr. Riker:

Q. Mr. Allen, this report contains your views with reference to these two projects, and your estimates of cost and maintenance?

A. Yes.

Q. You can testify to it without putting in a report, can you not?

(34)

CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF SEWER PLAN
MUNICIPAL BUILDING, ROOM 1238

Comp. Ex 248 Sheet 1.

March 16, 1918.

Mr. Nelson P.Lewis,
Chief Engineer.

Dear Sir:

I beg to submit revised estimates based upon pre-
war figures for the main drainage and sewage disposal of the
area tributary to the Harlem River and Bronx Kills from The
Bronx and Manhattan, amounting in 1960 to 265 mgd. and of
that part of Manhattan and Queens tributary to the Lower
East River and of the entire sewage of Brooklyn, amounting
in 1960 to 822 mgd; or a total of 1087 mgd.*

A comparison is made between the general
plan of the Metropolitan Sewerage Commission, known as the
"Outlet Island Project" (excluding the sewage collected
from The Bronx at and East of 149th Street which is to be
eventually carried to Rikers Island) and projects more
recently proposed by this office, called the "Hook
Island Project", by which disposal of most of the Harlem
River Sewage will be in the Hudson River instead of Hell
Gate, and disposal in the Upper Bay is substituted for
about 200 mgd in place of the ocean. In this comparison
the cost due 5-1/2 mgd to be delivered to West 155th Street
from the west side of Manhattan is excluded.

The volume of sewage involved and the cost
are estimated for 1960 as follows:

* On our more recent assumptions as to population these would be 963 and 1228 mgd. respectively.

I - Ocean Island Project

Point of Disposal	Sewage Flow mgd.	Treatment	Equivalent Raw Sewage mgd.
Wards Island	265	Sedimentation	132
Lower East River	300*	Fine screening	250
Upper Bay	170*	Fine screening	142
Outlet Island	352	Sedimentation	176
Total	1087		700

Estimated cost of construction $41,403,000

Total annual charges $ 3,584,000

II - Red Hook Island Project

Point of Disposal	Sewage Flow mgd.	Treatment	Equivalent Raw Sewage mgd.
Hudson River at Spuyten Duyvil	42	Fine screening	35
Hudson River off 155th St	81	Fine screening	68
Hell Gate off Wards Island	142	Sedimentation	71
Lower East River (Isolated Plants	301	Sedimentation	150
Upper Bay (Isolated Plants	170	Fine screening	142
Upper Bay off Red Hook Island	199	Sedimentation	100
Rockaway Inlet off Barren Island	152	Sedimentation	76
Total	1087		642

Estimated cost of construction $32,10 ,000

Total annual charges $ 2,979,000

* Acc. 100-A737 - Rep. K.A.-G.A.S.Nov. 5, 1913.

Comp. Ex 248 Sheet 2.

Assuming a reduction in putrescible organic matter of 50 per cent with sedimentation and 16-2/3 per cent with fine screening, the equivalent raw sewage delivered to the several parts of the harbor in 1960 from the points of collection here considered are found to be:

	Ocean Island Project	Red Hook Island Project
Hudson River	-	103
Hell Gate and Lower East River	382	221
Upper Bay	142	242
Rockaway Inlet and Ocean	176	76
	700	642

If sedimentation were used in the Ocean Island Project for the isolated plants along the Lower East River, as has been assumed for the Red Hook Island Project, the equivalent raw sewage entering that stream would be 100 mgd less, or 282 mgd, as against 221 mgd in the case of the Red Hook Project, and the total would be reduced from 700 to 600 mgd.

The estimates indicate a material economy in the Red Hook Project and a greater relief of the Lower East River but at the cost of an increased pollution of the Hudson River and Upper Bay, and while some 200 mgd is removed from the Lower East River by each plan a part of this will re-enter the stream with the flood current in the Red Hook plan. The forthcoming decision as to the discharge of the Passaic Valley sewage into the Upper Bay also has an important bearing on the final conclusion.

Respectfully submitted,

Kenneth Allen

Sanitary Engineer.

Comp. Ex 248, Sheet 3.
KHY

Estimate of Cost

For the Disposal of the Sewage of Manhattan and The Bronx

Tributary to the Harlem River

A - Wards Island Project.

Based on 265 mgd.

Construction	
Main drainage: Interceptors, Pumping Station, Outfall tunnels and Outlets	$7,657,000
Treatment works: Imhoff tanks, Conduits, Sludge equipment, Waterfront improvements	2,600,000
	$10,257,000
Gross Annual Charges	$ 938,000

OUTLET ISLAND PROJECT - DISTRIBUTION OF COST

5. Estimate of Cost.

A. Construction

	References	Manhattan	Brooklyn	General	Total
Tide Gates	41-A485-6	$ 37,900	$ 29,200	$	$ 67,100
Regulators	39-A547	29,300	26,600		55,900
Grit Chambers		115,000	125,000	25,000	265,000
Marginal sewers	13.22-A556-557	37,740	157,880		195,620
Interceptors	45-A549, 558-9	1,288,470	828,430		2,116,900
East River tunnel	45-A559			348,100	348,100
Main Sewer	45-A549-559			9,008,400	9,008,400
Pumping Stations	15-A545	20,000		828,000	848,000
Outlet Island	34.5-L6			615,500	615,500
Screening Plant	20-A553			100,000	100,000
Dortmund tanks	20.21-A514			1,125,000	1,125,000
Outlet well & outlets	47.3-A548			34,700	34,700
Sludge steamer				140,000	140,000
		$ 1,528,410	1,157,110	12,224,700	14,920,220
Contingencies- 15%		229,290	175,090	1,833,700	2,238,080
TOTAL COST.....		$ 1,757,700	1,342,200	14,058,400	17,158,300 *

B. Annual Charges

a. Operation and Maintenance.

Maintenance of sewers	100-A571	2,209	2,121	4,140	8,470
Grit chambers	20-A533	8,000	2,000	1,000	11,000
Pumping Stations	15-R87	1,000		250,250	251,250
Screening Plant	100-A551			60,000	60,000
Sludge disposal	20.81-A515			28,640	28,640
		$ 11,209	4,121	392,190	407,520

b. Fixed Charges

$ 1,757,700 x .0506 =	$ 88,940			
1,342,200 x .0506 =		67,910		
14,058,400 x .0506 =			711,360	
17,158,300 x .0506 =				868,210
TOTAL ANNUAL CHARGES.....	$ 100,149	72,031	1,103,550	1,275,730 *

*-Revised later to $17,394,000 and $1,311,500 as stated on Page 7.

Comp. Ex 248 Sheet 5.

Estimate of Cost

Of the Outlet Island Project

Chargeable to the Brooklyn Area Tributary to Jamaica Bay

Based upon 152* mgd

Interceptor, east of Flatbush Ave.	$2,856,400	
Interceptor, west of Flatbush Ave.	3,151,200	
Grit Chamber	90,500	
Pumping Station	448,000	
Treatment Plant	961,000	
Tunnel to Outlet Island	2,034,200	
Outlet Well and Outlets	34,700 **	
	$9,576,000	
Contingencies 15%	1,436,000	$11,012,000 #

* As this includes 15 mgd from Queens (Genesee Street), no allowance is made for sewage entering from west of Caisson No. 4 (from Coney Island etc.)

** Assumed the same as for the 203 mgd from the East River area, as they would probably have to be longer. No additional cost for land on the island is added as the area already provided for the East River sewage will probably suffice.

The cost if taken to Barren Island (Project C) - $7,536,000

Estimate of Cost

For the Disposal of the Sewage of Brooklyn and the Lower East Districts of Manhattan and Queens.

1960

A. Outlet Island Project.

	Mgd	Construction	Gross Annual Charges
Outlet Island from Lower East River Proj. XVII-MSC-1914*	200	$17,394,000	$1,311,500
Isolated Plants Proj. XVII-MSC-1914**	470	2,740,000	467,600
		20,134,000	1,779,100
Outlet Island from Jamaica Bay Proj. E - BPI-1918#	152	11,012,000	867,200
TOTAL	822	$31,146,000	$2,646,300

Note: By comparing the figures for Jamaica Bay with those where disposal is at Barren Island the construction cost in going to Outlet Island is seen to be $1,680,000 greater but the gross annual charges are $44,800 less.

As the flow from Genesee Street, Queens, is taken care of it is assumed that this will offset the omission of Coney Island's sewage, for which no provision is made in the estimate.

* Rep. K.A. - MSC Apr. 3, 1914, Acc. 100 - A731

** Rep. K.A. - MSC Apr. 8, 1914, Acc. 100 - A735, 737

\# Acc. 2.1 JB1590, 2103

B - Hudson River Project

Based on 265 mgd.

Construction

Northern Division, comprising disposal of 42 mgd at Spuyten Duyvil	$950,000
Middle Division, comprising disposal of 81 mgd off West 155th Street	2,509,000
Southern Division, comprising disposal of 142 mgd on Wards Island	
a. Collection of 65 mgd from Manhattan	428,000
b. " " 77 " " The Bronx	1,191,000
c. Treatment works - Wards Island	2,876,000
	$7,954,000

Total Annual Charges

Northern Division - Spuyten Duyvil	$ 99,700
Middle Division - West 155th Street	218,200
Southern Division - Wards Island	442,200
	$760,100

B. Red Hook Island Project.

Construction	Mgd.	Construction	Gross Annual Charges
Red Hook Island from Lower East River			
Proj. XVIII - MSC-1914*	199	$9,991.300	$ 779,200
Manhattan Sedimentation Plants			
Proj. XVIII - MSC-1914**	193	4,184,000	300,400
Brooklyn Screening Plants			
Proj. XVII - MSC-1914#	278	750,700	232,600##
Jamaica Bay			
Proj. C - BPI-1917L	152	9,228,000	906,700
TOTAL	822	$24,154,000	$2,218,900
Additional cost of Outlet Island Project		6,992,000	427,400
Or, if Jamaica Bay sewage goes to Barren Island.....		5,208,000	466,900

Note: In comparing the two projects it is to be remembered that the Red Hook Island Plant would return half the organic matter to the Upper Bay - an equivalent of 100 mgd raw sewage - and that if it should ever be necessary to extend this to an ocean island, the total cost would be much more than by carrying out the Ocean Outlet project at first. The same treatment is estimated in either case except that a longer settling period is allowed for the Red Hook Project.

* Rep. K.A. - MSC Jun. 5, 1914

** Rep. K.A. - MSC Jun.25, 1914, 375 mgd - Acc. 100 2 H 80, 82

\# Acc. 21.2 A736 Plants $592,800. Outlets $60,000 15% 97,900 145 mgd

\#\# Rep. Main Drainage & Sewage Disposal, P. 54

L Acc. 100 A737

Items of Estimated Cost.

	Outlet Island	Red Hook Island
Area	20.4 acres	20.4 acres
Island	$ 615,500	$392,000
Treatment Plant	1,125,000	1,590,000
Tunnel to Mainland	3,605,000	456,000
Tunnel Coney Island to Wallabout Pumping Station		4,676,000

To each of these items 15% should be added to cover contingencies.

MAIN DRAINAGE
FOR
NEW YORK CITY
PROPOSED BY
METROPOLITAN SEWERAGE COMMISSION

April 1914

A. I can, yes.

Q. The diagram which appears as the last paper in this offer was prepared by you?

A. No.

Q. Who was it prepared by?

A. That was prepared by Mr. Arthur H. Pratt, who was the Assistant Engineer of the Sewer Plan Commission in 1914. I speak now of the red line shown on the drawing. The plan itself is the plan of the Metropolitan Sewerage Commission, recommended by them.

Q. You had nothing to do with it, had you?

A. I had a good deal to do with it.

Q. What did you have to do with it?

A. I made numerous reports on the project in all its phases.

Q. I mean in the preparation of this plan.

A. Oh, no, not this particular print with its red lines, no.

Q. But it is referred to in your report, is it?

A. Yes, I am not sure that it refers to this particular print or not. I am not sure whether this report makes a single
766 reference to it or not.

Q. The estimates of cost, were they made by you personally?

A. Yes.

Q. And the estimates of cost and maintenance, were they made by you personally?

A. Yes.

Q. What action has been taken upon your report, if you know?

A. Nothing. No action was suggested. It was to present the comparative economy of the two plans, and the report was not made in answer to any request from the Chief Engineer. It was merely to furnish him with information.

Q. Both plans discussed by you in this report are feasible, are not they?

A. Yes.

Q. Only one is more costly than the other?

A. Yes.

Mr. Riker: No objection to Exhibit No. 248.

Report received in evidence and marked Complainant's Exhibit No. 248.

(Here follows report and diagram marked page 766a.)

By Dr. O'Sullivan:

Q. On May 1st, 1918, did you submit a report to Mr. Nelson P. Lewis, the Chief Engineer of the Board of Estimate and Apportionment, in your official capacity as Sanitary Engineer of the Board of Estimate and Apportionment in relation to the pollution of the Upper Bay?

A. I did, with particular reference to the possibility of a more highly clarified effluent, in case the Red Hook Island project was adopted. In that connection I made estimates of treatment by two plans that are hardly more than in their experimental stage at present, but one of which has been adopted by the City of
767 Milwaukee, and the other has been adopted for a part of the New Haven sewage. The first method is known as the activated sludge process, and the second as the Miles acid process.

Q. Will you state in full what that report was—read it in the record.

By Mr. Riker:

Q. Now, before the witness undertakes to read this paper in—when was that prepared?

A. May 1st, 1918.

Q. It contains matter within your knowledge?

A. I have seen the activated sludge process in operation, if that is what you mean. The Miles process I have not seen in operation.

Q. And you have described it in that paper that you are about to read?

A. Yes.

Q. What else is in that paper that is not within your own knowledge, if anything?

A. The principal object of the paper is to present cost-data and cost-data I could not get myself, because I never operated one of these plants, so that I have obtained them from other parties and reports and literature on the subject, and letters from personal friends.

Q. In describing this paper, it was said to contain a report upon the pollution of the Upper Bay.

A. It has particular reference to that, because the whole
768 Red Hook Island project depends on the pollution of the Upper Bay.

Q. Is there matter in there relating to the pollution of the Upper Bay?

A. Very intimately, yes.

Q. What?

A. Very intimately, yes.

Q. Where did you get the data, which you have described in that report, so far as the pollution of the waters of the Upper Bay are concerned?

A. I am not sure that the degree of pollution is mentioned. I give some oxygen figures.

Q. Did you prepare those oxygen figures?

A. Yes.

Q. Where did you get the data from?
A. I got the data from the analyses that had been made under my direction.
Q. You did not do the sampling?
A. No.
Q. You did not do the actual determination of oxygen?
A. No. I had a reliable chemist employed for that purpose.

Mr. Riker: I object to the reading by this witness of that paper in question, and ask that the witness be subjected to the ordinary course of examination, by question and answer.

The Commissioner: Note the objection of counsel for the defendants.

Dr. O'Sullivan: The request that the witness read this report is urged by the complainants' counsel, for the reason that it discloses an answer to the Order of the Supreme Court of the United States, of March 10, 1919, and shows what the City of New York has been doing to minimize the polluting effect of its riparian sewage,
769 and that every known method and scheme feasible for use by the authorities of the City of New York have been under consideration, and many of them have been adopted. Many are exceedingly expensive, and it became necessary for this witness, as Sanitary Engineer of the Board of Estimate and Apportionment, to submit for the informative value, all data regarding sewage disposal systems, wherever in operation and efficiently worked.

By Dr. O'Sullivan:

Q. You may read that.
A. (Reading:)

"City of New York,

Board of Estimate and Apportionment,

Bureau of Sewer Plan.

Municipal Building, Room 1235.

May 1, 1918.

"Mr. Nelson P. Lewis,
Chief Engineer, Board of Estimate and Apportionment.

DEAR SIR:

The most important problem regarding the future disposal of New York's sewage—that relative to Brooklyn north of the Jamaica Bay territory—remains unsolved and as this has a definite bearing on plans for other parts of the City, such as the east half of Manhattan, it is desirable to consider what information is available on this subject from every point of view and formulate the general
770 outlines of the best plan to be recommended at an early date.

"Some aspects of the problem as bearing on the pollution of the Bay have been touched on in my report on Dissolved Oxygen of

February 2, 1918, and some estimates handed you under dates of March 16th and April 8th, have given a rough measure of the comparative costs involved by the adoption of disposal with sedimentation on Outlet Island in the Ocean and Red Hook Island in the Upper Bay. In the following communication I beg to submit additional information regarding the modification of these two schemes with especial reference to the sewage entering the Lower East River and Upper Bay from Manhattan, Brooklyn and Queens.

"Sedimentation and Screening.

"It would appear that by the disposal of some 670 mgd. of sewage tributary to the Lower East River and Upper Bay in 1960 after plain sedimentation on an artificial island off Red Hook and by isolated plants in the Lower East River and the Upper Bay there would be a saving roughly estimated at $4,830,000 in the cost of construction and $349,000 in gross annual charges as compared with the plan of disposal after similar treatment on an island to be constructed in the ocean off Coney Island, supplemented by isolated plants, viz.:

771

Project.	Mgd.	Cost of construction.	Gross annual charges.
Outlet Island.			
To Island from Lower East River	200	$17,394,000	$1,311,500
*To Isolated Plants from Lower East River and Bay	470	3,761,000	551,000
Total	...	$21,155,000	$1,862,500
Red Hook Island.			
To Island from Lower East River	199	$9,991,300	$779,200
*To Isolated Plants from Lower East River and Bay	471	6,333,700	734,100
Total	...	$16,325,000	$1,513,300
Saving by Red Hook Island Project	..	4,830,000	349,200

"It is believed that fine screening at Outlet Island would be entirely adequate for the treatment of 200 mgd. at this point. Screening costs are somewhat problematical but a tentative estimate sub-

*"Estimates for Isolated Plants have been revised since those of March 16th and April 8th, 1918, were submitted.

stituting this for sedimentation reduces the first cost of the
772 Outlet Island project by $682,000 or to $20,473,000. This is $4,148,000 more than by sedimentation on Red Hook Island, while the annual charges would be $1,877,400 or $364,000 more than by the Red Hook plan. Furthermore, the initial outlay would be greater in the case of the Outlet Island plan.

"Pollution of the Upper Bay.

"In my report of February 2, 1918, on Dissolved Oxygen, I mentioned (p. 18) the detrimental effect that would ensue from a discharge of the Passaic Valley sewage at Robbins Reef together with a large volume off Red Hook. It was also shown that near the location of the two proposed outlets the saturation of dissolved oxygen has reached the following figures: (Tables VI-X).

Year.	Robbins Reef Bell Buoy.	Gowanus Bay.
1914	70%	31%
1915	58%	37%
1916	51%	33%
1917	42%	26%

"Now, the objection to a discharge off Red Hook would be removed if the sewage were subjected to a sufficiently high degree of purification. The most intensive method—that is, the one occupying the least ground—in the standard practice of today—is by trickling filters; but objections to this are the great area
773 that would be required—something over 100 acres—the possibility of odor under certain conditions with so extensive a plant and its cost—say ten million dollars besides the annual expense of pumping the sewage 15 or 20 additional feet.

"There are, however, possible alternatives in the activated sludge process and the Miles acid process, both of which offer a certain return from utilization of the sludge.

"The Activated Sludge Process.

" 'The Activated Sludge Process is the agitation of a mixture of sewage with about 15% or more of its volume of biologically active liquid sludge in the presence of ample atmospheric oxygen, for a sufficient period of time at least to coagulate a large proportion of the colloidal substances, followed by sedimentation adequate for the subsidence of the sludge flocculi; the activated sludge having been previously produced by aeration of successive portions of sewage and maintained in its active condition by adequate aeration by itself or in contact with sewage.' (Am. Pub. Health Assoc.)

"The process was first developed in 1913 by Dr. Gilbert Fowler and Messrs. Ardern and Lockett at Manchester, England, fol-
774 lowed in this country by Dr. Bartow of Urbana, Ill., Messrs. Hatton and Copeland at Milwaukee and others. A 2 mgd.

plant is in operation and one of 85 mgd. in process of construction at Milwaukee and in all 25 or more plants had been built up to last December.

"Dr. Fowler describes it as a process of 'intensive bacterial oxidation.' In other words it accomplishes the work of a trickling filter plant on a fifth of the area, removing (at Milwaukee) 99% of the suspended matter and 99% of the bacteria while producing a stable effluent. A comparison of the cost of the two methods based on a flow of 5½ mgd. was made by Mr. H. P. Eddy indicating by:

	Trickling filters.	Activated sludge.
First cost, per mgd.	78,500	$57,100
Total annual charges, per mgd.	21.84	29.85

"The higher cost of operation indicated for activated sludge may be more than offset under favorable conditions by utilization of the sludge, which contains a high percentage of ammonia in a form available as fertilizer.

"It is estimated that a plant to handle 200 mgd. of sewage and product dry fertilizer and grease on Red Hook Island would cost some $10,500,000, based on 1916 prices, which are assumed to be about what will be maintained after the war.

775 "The annual charges of operation for treatment, exclusive of sludge disposal, are estimated at about $1,200,000

To this should be added for sludge disposal:

Pressing 2,920,000 tons of wet sludge to 343,090 tons of cake at $1.40 per ton of cake	$340,000	
Drying 343,090 tons of cake to 64,970 tons of fertilizer base at $2.74 per ton	160,000	
		500,000
		$1,700,000
Fixed charges $10,500,000 at 5.06%	531,000	
Depreciation $500,000 @ 15%	75,000	
		606,000
Total Annual Charges		$2,306,000

"In the original project, involving plain sedimentation the

Cost of Plant	$1,828,500	
Annual Operation including sludge disposal		$109,500
Fixed charges on plant		92,500
		$202,000

"The total annual charges are $2,104,000 greater by the activated sludge process, if we disregard any return from the sale of sludge. From analyses of Manhattan sewages made by this Bureau last year and of the dried activated sludge at Milwaukee, Urbana, Cleveland and the Packinghouse District, Chicago, and at Manchester
776 and Wakeford, England, and further, considering the rather low water consumption (90 gal. per cap.) and hence the probable density of the sewage of Brooklyn, it appears reasonable to suppose that the sludge dried to 10 per cent moisture would contain as much as

6	per	cent	ammonia
5	"	"	fats
1	"	"	phosphoric acid and
0 5	"	"	potash

"Although Pearse and Richardson, in reporting on the recovery of grease from the Packingtown, Chicago, sewage give the cost of reclamation as but 0.25 ct. per lb., it is understood (Letter from W. R. Copeland, Apr. 29, 1918) that there is a loss in the amount as ordinarily recovered over that contained in the sludge which practically amounts to about half of this 5 per cent. content and that up to the present time manufacturers have not considered the recovery of the balance worth its cost. For the same reason phosphoric acid and potash may be disregarded although these are worth about 10 and 75 cents. per lb. respectively, while grease, assumed at 6 cts., was a short time ago said to be selling for 20 cets. per lb. The prices are assumed for after-the-war conditions or practically those which obtained a couple of years ago. The revenue from the ammonia may then be taken as:

777	6 units @ $4.50	$26 per ton
	For 64.970 tons	$1,604,700

"The costs of operation have been pretty well worked out at Milwaukee. An important item is that for power. This is taken at 1.3 cts. per khw., assuming a degree of purification equal to that proposed for Milwaukee. At Milwaukee it is 0.5 cts. per kwh. With the large amount of power demanded, it is probable that the estimated cost might be reduced by the direct use of steam.

"NOTE.—It has been pointed out that the process has the advantages of being able to carry sludge aeration, with its consumption of power, merely far enough to secure an effluent sufficiently purified to satisfy the local and temporary demand. At Milwaukee, while 1.5 cu. ft. air per gallon of sewage is required for thorough treatment, it has been found that 95% of the suspended matter may be removed with 0.5 cu. ft. air per gallon and that a well oxidized effluent may be obtained with from .75 to 1.1 cu. ft. of air per gallon.

"If it were found that one-third of the cost of power could be saved in this way, the annual operating charges would be reduced from $1,700,000 to $1,553,000.

"This process will furnish an effluent far better than the water of the Bay, practically free from sediment or bacteria, and
778 with freedom from odors. In fact it may be taken as fully equivalent in its results to a disposal of the sewage in the Ocean.

"The Miles Process.

"The Miles process, after a series of experiments covering several years by E. R. Dorr at Moon Island, was patented in 1915 by George W. Miles. It consists in a separation of the sludge with the grease by acidulating the sewage, preferably with sulphur dioxide. This can usually be obtained at small cost of burning pyrites, but under present conditions as there is no supply at reasonable cost, a cheap substitute is found in the production of sulphuric acid from nitre-cake, a by-product from the manufacture of smokeless powder. The sludge is dried to 10% moisture and the grease recovered by percolation much as in garbage reduction, leaving the tankage with its contained ammonia free from grease and in a favorable condition to use as a fertilizer.

"The several processes involved, viz., settling, pressing, drying and degreasing by percolation, are all well established so that their cost can be estimated within reasonable limits.

"Estimates on plant to treat 200 mgd. are as follows:

779 Construction.*

Sedimentation plant			$1,590,000
Acidulation plant			200,000
Pressing and drying plant			420,000
Degreasing plant			227,000
			$2,437,000
Contingencies	15% of	$1,590,000	
	25% of	847,000	450,200
Total Cost			$2,887,200

Operation

Sedimentation	$109,500	
Acidulation	584,000	
Pressing and drying	365,000	
Degreasing	255,500	
		1.314,000
Interest and Depreciation		305,000
		$1,619,000

*Neglecting royalties. Contingencies on sludge plant are placed at 25% as the process has not yet been thoroughly tried out on a large scale.

Revenue.

Grease 32,850,000 lbs. @ 6 cts	1,971,000
Tankage 46,720 tons @ $20.25	946,000
	$2,917,000
Profit $2,917,000—$1,619,000	1,298,000

780 "In preparing this estimate I have endeavored to use safe figures although costs and returns are both properly somewhat larger than before the war. Besides a considerable amount of data furnished during the past three years by Mr. Dorr, I have obtained much information regarding costs of percolation and the market value of products from Mr. H. H. Bighouse, Manager of the C. O. Bartlett and Snow Company. Mr. Bighouse's connection with the Barren Island, Staten Island and other reduction works makes him a competent authority on these matters.

"Another figure furnished by Mr. Dorr, in a letter dated April 23, 1918, is as follows. Mr. Dorr says:

" 'If your sewage runs 80 ppm. (of fats) you should get X X 631 lbs. (grease per mg.). If you assume 625 lbs. at 15 cts. a pound, you would get $93.75 per mg. for grease.

" 'Boston sewage yields ¾ ton degreased fertilizer, with ammonia content 4.50%.

" 'Yours would probably give more and richer but assuming the same, with ammonia at $6.50 per unit, it would be worth $29.25 per ton, $21.93 per mg.

" 'Grease and fertilizer would sum up $115.68 per mg. Calling it $110.00 would give $22,000 per day, $8,030,000 per year.

" 'Cost of process could hardly exceed one-half of this, $55
781 per mg. even allowing for excessive cost of detention basins.

" 'This would leave about $4,000,000 per year to the good.' Compared with this, my estimate of $1,298,000 does not appear unreasonable."

(I think those figures would be modified today, however, because prices have changed somewhat since that time.)

"Unfortunately the process has not gone beyond the experimental stage. It has, however, been investigated by Prof. R. S. Weston who corroborated Mr. Dorr's analyses and points out that besides being a strong disinfectant, the acid decomposes the soaps and so makes available a larger percentage of fats than would otherwise be found and believes the process to be 'more promising economically than any other known.'

"In 1913 Mr. H. W. Clark, Chemist, Massachusetts State Board of Health, stated as his opinion that 'as the process of drying, pressing and fat separation are improved and also as nitrogen advances in price, as seems inevitable, sewage sludge will become of greater agricultural value than it is at present.' Since the war this change has come about very rapidly. Nevertheless, we must not
782 forget that with the much richer sewage at Bradford, England, treated with sulphuric acid, there appears to have been no net profit up to last year, although both the operating costs and revenue from grease and fertilizers were estimated at about $365,000 for 1917."

(I understood that recently they have been found exceedingly profitable on account of war conditions.)

"Also, as mentioned by Mr. Clark, the greater part of the rich wool scouring wastes from Massachusetts mills is still allowed to be wasted.

"Referring to the activated sludge and Miles processes, Prof. C-E. A. Winslow says that it seems 'that the possibility of recovering at least a large part of the cost of sludge disposal is already within our grasp,' while referring to experiments being made at New Haven on the Miles Process he says 'we get a satisfactory disinfection of the effluent and sludge that is very rich in grease' and of 'high stability.' Prof. Weston adds. 'Even if the (Miles) process should prove only self-supporting, it would at least have the advantage of discharging a partially clarified and nearly sterile effluent into bodies of water now receiving nuisance-producing * * * sewage, at a cost far below that of any process of equal bacteriological and nuisance-preventing efficiency.'

783 "In other words, if we assume that Imhoff tanks will remove 30% and, to be conservative, the activated sludge process in practice 90% of the putrescibility of the effluent, it may be tentatively assumed that with the sterilized but unoxidized effluent of the Miles process the putrescibility before passing out through the Narrows has been reduced by 60%. An improvement to this extent would probably be sufficient for all time under the assumed conditions of development in 1960 and the location of discharge in the Upper Bay.

"Yet there remains unexplained the reason why acid treatment and the utilization of grease and fertilizer have not been more generally adopted. It is understood that the grease in some analyses has been found of inferior quality. Estimates on a small plant (costing $59,000) made by Daniels and Rosenfeld at Cornell University showed, with grease at 4.4 cts. per lb. and fertilizer at 50 cts. per ton, a net annual loss of $17,735., and in a report recently presented by Goodnough and Clark relative to the application of the Miles process to the Metropolitan District of Boston, they give as their opinion that 'the expenditure of money for the recovery of marketable wastes from the district sewage would be unwarranted until large-scale experiments had demonstrated the commercial

practicability of the scheme.' And Mr. Copeland advises that
784 'commission houses, such as fertilizer manufacturers, etc., have not considered heretofore that it pays to attempt to recover fats unless the raw material contained at least 10%' although he adds that it may pay 'to extract a 5% product in the future, especially if handled on a large scale.'

"More light is evidently needed before the true merits of the process can be positively affirmed. Possibly the results obtained at New Haven when published will help in this direction, but the apparent advantages are so great, the returns so profitable, and the fact that as yet no one seems to have put his finger on the weak spot leads one to hope that grounds for scepticism are not well founded." (Since then, as I have mentioned, these experiments at New Haven have been completed and the works recommended.)

"Partial Use of Miles Process.

"Examinations of the harbor water show that the oxygen content remains high—usually over 60% saturation—during most of the year. In 91 samples taken from all the main branches of the harbor, this year up to May 1st, but 2 show a saturation of oxygen less than 60%, viz. 54% in the Hudson off Pier A April 17th and in the Harlem off East 106th Street. If, therefore, the 200 mgd. of sewage collected at Red Hook Island were treated by sedimentation in Dortmund tanks during the months of October to May inclusive, and if treated by the Miles process during the remaining warm months, it is
785 probable that every sanitary requirement would be met.

"An estimate has been made on this assumption, omitting, however, any attempt at the recovery of grease or fertilizer, the sludge being dumped at sea with that from the proposed isolated plants.

Estimate.

Construction.

Collection to Red Hook Island with disposal by sedimentation	$9,991,300	
Acidulation plant	250,000	
Isolated plants	6,333,700	
		$16,575,000

Annual Charges.

Operation.

Collection and disposal on Red Hook Island	555,850	
Collection and disposal at Isolated plants	407,200	
	$963,050	
Fixed charges	876,200	
Total		$1,839,250

"The advantages of this plant would be:

a. It could be built piecemeal and operated at first with sedimentation only.

b. The effect and cost of acidulation can be pretty closely predicted and this can be added when, and operated as many months as, necessary.

786 *c.* The first cost would be less and, if we omit the Miles process with grease recovery, the annual charges would be less than by any other plan likely to prove satisfactory.

d. If the recovery of grease and fertilizer should prove profitable, the necessary plant could be added at any time.

"Summary and Conclusions.

"The total cost of providing for the 670 mgd. of sewage entering the Lower East River and the east side of the Upper Bay in 1960 is estimated as follows:

Comprising—	Construction.	Annual expense.
A. Outlet Island with Imhoff tanks*	21,155,000	$1,862,500
B. Outlet Island with fine screens	20,473,000	1,877,400
C. Red Hook Island with Imhoff tanks*	16,325,000	1,513,300
D. Red Hook Island with activated sludge	24,997,000	1,971,500**
E. Red Hook Island with Miles Process	17,384,000	72,000
F. Red Hook Island with Miles Process (partial)*	16,575,000	1,839,300

"From the above statement we may draw the following conclusions, it being assumed that sedimentation alone would be inadequate at Red Hook Island and that the activated sludge and Miles processes prove successful after further use:

787 *a.* Although fine-screening would probably suffice for all time at Outlet Island, its economy relative to sedimentation cannot be definitely stated without more detailed estimates.

b. The activated sludge process will furnish a satisfactory method of disposal at Red Hook Island. It would cost about $3,800,000 more than the Outlet Island project and $110,000 more annually but would have the advantage of being susceptible to gradual development, while the initial cost of the Outlet Island project would be very great.

(Notes in connection with * and ** on preceding page:) * Royalties on these patented processes are not included in the estimates. ** $1,825,000 if the air consumption could be cut down one-third, as is possible.

c. If the Miles process with reclamation of grease and fertilizer should prove satisfactory there would be a saving of nearly $3,800,000 in first cost and $1,800,000 annually over the Outlet Island project.

d. If the Miles process were employed from June 1st to October 1st but with no attempt at utilization of the sludge and plain sedimentation for the other eight months, there would be a saving of nearly $4,600,000 in first cost and $23,000 annually over the Outlet Island project.

e. As between the activated sludge and the Miles processes, the latter seems to have the advantage in:

788 "1. Costing $7,600,000 less at first and $1,900,000 less annually.

"2. Being a somewhat simpler process to control.

"3. It is believed that either process properly carried out would be free from odors but that in the case of negligence the Miles process would offer less opportunity for their development.

"On the other hand, it has already been pointed out that the Miles process is yet in the experimental stage and the amount of returns from sludge problematical, and that the activated sludge process would produce a superior effluent.

"*f.* A partial use of the Miles process as described offers the following advantages:

1. A saving in first cost of $800,000 over the complete process.

2. The possible employment of sedimentation only at first resulting it a further saving in the first cost.

3. The ability to extend operation as many months of the year as desirable and to convert the plant into one comprising the utilization of the sludge if found advantageous later.

"In short, if the tentative estimates upon which my conclusions are based are correct, the entire cost of this improvement,
789 comprising the collection and disposal of all the sewage entering the East River south of Hell Gate and the Upper Bay from Brooklyn in 1960 could be met by an annual expenditure of $1,972,000 if 200 mgd. from Brooklyn were treated by the activated sludge process or $1,840,000 if treated for 4 months of the year by the Miles process with the ability to reduce this to but $72,000 by continuous operation and utilization of the sludge.

"The Lower East River, which is approaching a serious degree of pollution would be permanently cleansed by the adoption of either of these plans and the Upper Bay made free from any excess of pollution due to New York's sewage. The work could proceed by instalments and there would be no necessity for the high first cost involved in a tunnel to the ocean.

"The development of the activated sludge and the Miles methods of treatment should be carefully watched as having an important bearing upon the economical disposal of Brooklyn's sewage.

Respectfully submitted,

(Signed) KENNETH ALLEN,

Sanitary Engineer."

(Whereupon, a recess was taken until 2:00 o'clock p. m.)

790 After Recess.

2:00 p. m.

KENNETH ALLEN, resumed.

By Dr. O'Sullivan:

Q. Mr. Allen, in the discharge of your duties as Sanitary Engineer of the Board of Estimate and Apportionment, did you submit a report on the main drainage and sewage disposal for Jamaica Bay?

A. I did.

Q. Have you got that report?

A. I have. The question of Jamaica Bay was somewhat pressing on account of the question of pollution of oysters, and although the City operated three chemical precipitation plants on sewage tributary to the Bay, these were antiquated and ineffective.

Q. Was your report transmitted, after submission to the Chief Engineer, Mr. Lewis, to the Board of Estimate and Apportionment?

A. It was.

Q. What is the date of that report?

A. March 19, 1917. In that report the sewage was considered in two general divisions, one comprising the territory north of Jamaica Bay, and the other Far Rockaway and the Rockaway Peninsula; and four plans were worked out for each area, and one of these four in each case recommended. The plan recommended for the Rockaways has been formally adopted as far as the collection of sewage is concerned, and the plans for treatment are being prepared.

791 Dr. O'Sullivan: I offer that report in evidence, and ask that it be marked Compainants' Exhibit No. 249.

By Mr. Riker:

Q. Where does Jamaica Bay discharge its waters?

A. Through Rockaway Inlet to the Atlantic Ocean.

Q. Beyond the Lower Bay?

A. Yes, just beyond the Lower Bay. The trend of the currents there is to the southeast.

Q. Have you identified any of the sewage from this territory as being taken up by the tides of New York Upper Bay?

A. No.

Q. You say that this report has been adopted, so far as the collection of the sewage is concerned, for the Rockaway District?

A. Yes.

Q. In what way, by what body has it been adopted?

A. By the Board of Estimate. The Borough of Queens prepared the plans which have been formally submitted.

Q. Who is preparing the plans for treatment?

A. The Borough is preparing the plans for treatment.

Q. Are they completed?
A. No.
Q. Have you had anything to do with them.
A. Slightly. I have had some conferences with the Engineer, but owing to other work he has deferred the completion of those plans.
Q. Does this report involve any plans for treatment of this particular sewage?
A. Yes.
Q. Have your plans for this district been rejected?
A. No.
792 Q. They are under consideration as part of the material from which they propose to form their final plans?
A. Yes.
Q. What relation has this report to the problem relating to the pollution of the purification of the waters of the Upper Bay?
A. It is quite distinct from that. It has no relation to that.

Mr. Riker: The offer is objected to on the ground that it is irrelevant and immaterial to the inquiry in this cause.

The Commissioner: Note the objection of counsel for the defendants.

(The paper was marked Plaintiffs' Exhibit No. 249.)

CITY OF NEW YORK

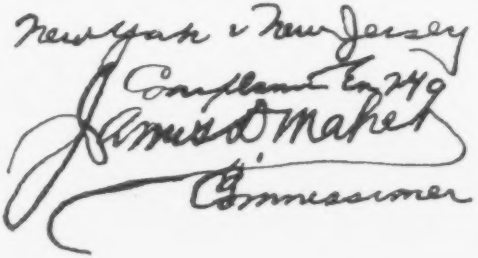
REPORT

ON THE

MAIN DRAINAGE AND SEWAGE DISPOSAL

OF THE

AREA TRIBUTARY TO JAMAICA BAY



S. L. PARSONS & CO., Inc.
45 ROSE STREET
NEW YORK

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THE BOARD OF ESTIMATE AND APPORTIONMENT

BUREAU OF PUBLIC IMPROVEMENTS

April 23, 1917

Hon. JOHN PURROY MITCHEL, *Mayor, Chairman of the Board of Estimate and Apportionment:*

Sir--On June 13, 1916, the President of the Borough of Queens transmitted to the Board of Estimate and Apportionment a tentative drainage plan for what is designated as Sewerage District 41 in the Borough of Queens. This district lies south and southeast of the Village of Jamaica and includes an area of about 3,500 acres. A comprehensive plan for the sewerage and drainage of the southerly part of the Borough of Queens has not yet been worked out in detail and submitted to the Board of Estimate and Apportionment by the Borough authorities, and it is assumed that those responsible for this work will be glad to avail themselves of the results of a study of the problem in its larger aspects.

The entire territory within the City of New York lying south of the ridge between the East River and the Atlantic Ocean and including large portions of the Boroughs of Brooklyn and Queens, while it might naturally be divided into a number of separate sewerage districts, must ultimately discharge both its sewage and storm water either into Jamaica Bay or the Atlantic Ocean. Topographically, therefore, it is one great drainage district and must be so considered in working out its sewerage problems. The mere fact that this great territory lies in two boroughs should not prevent its consideration as a single problem, even though the portions of the sewerage system and the plants for the treatment of sewage in the different boroughs were to be constructed and maintained by the respective borough authorities. For a considerable portion of the Borough of Brooklyn tributary to Jamaica Bay the plan has been quite fully developed and large portions of it have already been constructed, but, believing it desirable to make a comprehensive study of this entire district and its problems, Mr. Kenneth Allen, the Engineer of Sewage Disposal of this office, has prepared a report which I believe will be of substantial assistance to those upon whom may devolve the duty of working out the complete drainage plans for the portions of the two boroughs referred to. This report is not presented as offering any one plan that may not be modified on further study, but rather as outlining the broad features in a fairly definite way of several available plans as a guide in the final selection, with reasons for carrying out certain recommendations, trusting that they will commend themselves to those whose decision in the matter

must be final. Mr. Allen's studies have necessarily been predicated upon estimates of future population, and in making these estimates he has made use of curves deduced from past increases in population. While this is almost invariably done, I feel by no means certain that these estimates will prove to be accurate. Many of our large cities have experienced sensational growths, far exceeding the most extravagant estimates, but it may be doubted whether such rates of increase will be maintained. There is a belief that further centralization of population should be discouraged and that the problems of supplying cities or metropolitan districts numbering their population by the millions will be so great and the cost of living and doing business in them will increase to such an extent that there will be a natural tendency toward decentralization. Even if the estimates of future population are not realized, the wisdom of using them in planning the general sewerage system will probably be admitted, as the sewers themselves will undoubtedly be built in several units; that is, two or more trunk sewers will be built in the same street and these units will be constructed only as needed. The same conditions will apply to the disposal works which would be extended only as the need for them may develop. The site suggested for the principal one of these disposal plants, namely, Barren Island, is sufficiently large to permit any extensions which may be called for.

The plan favored by Mr. Allen in his report provides for concentration of practically all of the sewage from the inner side of Jamaica Bay at Barren Island, where it would be discharged into the deep water and the swift currents of Rockaway Inlet. He estimates that this volume of sewage may amount, in 1960, to 300,000,000 of gallons daily and notes that the problem of disposal of this amount of sewage at one point may be so serious as to require a modification of the plan by taking a portion of it elsewhere for treatment and final disposition, in which case any one of several methods of relief which are mentioned may be readily availed of. The constant movement westward of the tongue of land known as Rockaway Point might justify the belief that the direction of the currents into which this sewage would be discharged will be such as to carry the polluted water more closely to and parallel with the bathing beaches on Coney Island, but, as Mr. Allen notes, past experience justifies the belief that, owing to the existence of a bar just west of Rockaway Point, the flow of the water from Jamaica Bay is definitely diverted in a southerly direction, and, judging by past experience, if this point continues to extend westwardly, a new channel will ultimately cut its own way through this tongue of land, so that the waters of Jamaica Bay will continue to find a fairly direct outlet into the ocean.

Consideration has been given to the possibility of a great commercial development in Jamaica Bay which would render it very undesirable to discharge sewage into the upper and more shallow portions of this body of water without a more thorough treatment than required at Barren Island.

The shellfish industries have also been considered and the investigations and conclusions of the State Department of Health and the Bureau of Chemistry of the United States Department of Agriculture have been noted. Their conclusions render it scarcely reasonable to expect that these waters can be so effectively protected as to render shellfish taken from them above suspicion. Certain large islands owned by the City in Jamaica Bay have been leased for a long term of years, and the lessees are developing this property for summer residences, with provisions for a sanitary disposal of sewage. It is obviously necessary that the methods of such disposal be carefully supervised by the City, in order that the large expenditures which the City will undoubtedly be called upon to make in order to protect the bay from unnecessary pollution will not be nullified to a certain extent by indifferent methods of sewage treatment employed by the City's tenants.

The southern shore of the Rockaway peninsula constitutes one of the best and most popular of the bathing beaches in or near the City and any plan for sewage disposal should recognize this and avoid any reasonable chance of injury through its pollution.

If the plans which have been proposed for the commercial development of Jamaica Bay, consisting of the construction of large islands, are to be carried out, the tidal prism will be greatly reduced. For instance, under present conditions, it is estimated that 300 millions of gallons of sewage discharged into the bay would be diluted in the proportion of 111 to 1, while, if the islands, above referred to, are constructed, this ratio of dilution would be reduced to 88 to 1, or about 21 per cent. It is estimated that about 50 million gallons of sewage a day are now discharged into Jamaica Bay, the amount varying from very small local discharges to about three million gallons at Paerdegat Creek and 25 million gallons from the 26th Ward disposal plant.

The various projects which have been considered, with the estimated cost of construction and operation, have been so arranged as to permit a ready comparison between them and to show which of the plans would involve greater or less initial cost and which would be the more economical in the long run. The report clearly shows the flexibility of the plans and that, as they are finally developed, it would be possible, with no material additional cost, to adapt them to conditions which may develop and to any improvements in the art of sewage treatment and disposal. The expenditures are given for each decade up to 1950. Interest has been figured at 4½ per cent., or, with amortization on permanent construction, at 5 per cent., and on mechanical equipment, at 9 per cent., provided the initial outlay for construction is not to be promptly recouped by direct assessment. The total expenditures will be large, involving for the entire period a sum which will approach $20,000,000 for construction usually assessed upon the property benefited, and approximately $500,000 annually for operation and maintenance of the completed plant in the territory north of Jamaica Bay, while

for the Rockaway peninsula the plan favored will involve about $1,500,000 for construction, and annual maintenance charges of about $72,000. None of these estimates, however, include the cost of the acquisition of property. The problem of financing so great an undertaking may be a difficult one. Original sewer construction has always been assessed upon the property in the drainage area. Much of the property in the territory under consideration on the north side of Jamaica Bay is marsh land of very low value, and it may be necessary to allow the assessments to be paid in a series of annual installments. The total cost, however, would amount to about $440.84 per acre for this entire district, or from about $13.15 to $9.20 per capita based upon the estimated population for the several decades over which the construction will be distributed.

I believe that this report constitutes a valuable contribution to the study of a large and a difficult problem. As already stated, it is not submitted as a final solution of that problem, but I believe that it will be of great assistance to those who are charged with responsibility for working out the final plans. I recommend, therefore, that the report, with the explanatory diagrams, be printed for distribution.

Respectfully,

NELSON P. LEWIS, *Chief Engineer.*

March 19, 1917.

MR. NELSON P. LEWIS,
Chief Engineer.

Dear Sir:—

A communication from the Acting President of the Borough of Queens, dated June 13th, 1916, requesting the approval of a tentative drainage plan for Sewerage District No. 41, has been handed to me for investigation. The plan relates to various alterations in the existing sewerage system serving Jamaica and vicinity, and hence is within the area naturally draining to Jamaica Bay.

After considering any plan contemplating the development of the drainage facilities for any considerable part of the area tributary to Jamaica Bay, it will be recognized that this is but a part of the larger problem involved in the main drainage and sewage disposal for the entire area. If we except the Rockaway peninsula, which is separated from the balance of this area by the intrusion of Nassau County to the head of the bay, the local areas are contiguous and have no natural barriers due to topography. Furthermore, the waters of the bay have a limited capacity to receive and dispose of sewage without offense, the different parts of the bay varying largely in this respect on account of depth, current, proximity to high class developments and to the connection with the ocean by way of the inlet. The determination of the methods of treatment, points of outlet and permissible volumes to be discharged at selected points are all interrelated and have an important bearing

on the future development of this part of New York. It is, therefore, believed that the matter should be considered as a single problem and approached in the broadest possible way. The final plan for each subdivision of this large area should then be so related to the others that the result will afford the most satisfactory and economical solution, having regard for both present and future conditions.

I, therefore, beg to submit the attached report on the main drainage and sewage disposal of the area tributary to Jamaica Bay.

Very respectfully,

KENNETH ALLEN,

Engineer of Sewage Disposal.

REPORT

SUMMARY AND CONCLUSIONS

The area within the City limits which drains to Jamaica Bay, is 71 square miles. In 1915 it contained a population of 436,000, but within 40 years this may be expected to increase to over 2¼ million persons, furnishing a volume of sewage amounting to nearly 300,000,000 gallons per day, of which about 24,000,000 gallons will come from Far Rockaway and the Rockaway peninsula. This area is disconnected from the larger area north of the bay and, except as to its effect upon the waters of the bay, is considered as a separate problem.

The waters of the bay which cover, including its islands, 28 square miles are already badly polluted locally by the discharge of sewage from the Far Rockaway, Jamaica and 26th Ward Disposal Plants and at Paerdegat.

The relief of this situation has received considerable study in the past and now calls for solution.

Four general projects have been worked out for the area north of the bay and an equal number for that lying to the south. The distinctive features of these two sets of projects are shown in the following summaries:

For the North District or the area lying north of Jamaica Bay:

Project A provides for the interception and disposal of the entire 272,000,000 gallons per day in Rockaway Inlet after treatment by settling in tanks on Barren Island.

Project B provides for a similar disposal of 208,000,000 gallons daily collected from Jamaica and the territory to the west, while 63,000,000 gallons from the east would be pumped to Jo Cos Marsh, treated by oxidation, and discharged into Broad Channel.

By Project C the 119,000,000 gallons collected at and west of Genesee Street would be carried to Barren Island and the balance to Jo Cos Marsh, with disposal as in Project B.

By Project D the 173,000,000 gallons reaching Hendrix Street from Fresh Creek Basin on the west and Jamaica on the east would be treated by oxidation and discharged near the head of Big Channel. The 64,000,000 gallons collected to the west would be discharged into Rockaway Inlet after fine screening and the 34,000,000 gallons from the area east of Jamaica would be carried to Jo Cos Marsh, as in Projects B and C.

For the Rockaway District, embracing Far Rockaway and the Rockaway peninsula:

Project A contemplates carrying the entire 24,000,000 gallons per day to Silver Hole Marsh for oxidation and disposal in Broad Channel.

By Project B it would be collected at Beach 116th Street, pumped to Little Egg Marsh, settled in tanks and discharged into The Raunt.

By Project C it would be collected at Beach 149th Street, passed through fine screens and discharged into Beach Channel.

By Project D it would be collected at Beach 69th Street, Beach 96th Street and Beach 129th Street. At each of these localities it would pass through settling tanks and be discharged into Beach Channel.

Project A for the North District and Project C for the Rockaway District are recommended, including temporary oxidizing treatment at Hendrix Street and near Jamaica, as, on the whole, best meeting the requirements—sanitary and financial—but with the possibility of so modifying the plans for the North District in the future as to conform to Project B, with oxidation of the sewage of Queens lying east of Jamaica at Jo Cos Marsh, if this should be found desirable.

The sewerage of Far Rockaway is assumed to remain practically as at present, but the flow collecting to the existing Disposal Plant will be pumped, and then flow by gravity to the proposed fine screening plant at the north end of Beach 149th Street, auxiliary pumping being required at Beach 97th Street.

The entire improvement is estimated to cost $20,870,000 within the next 25 years and to suffice for the demands 40 years hence, when the gross annual charges for maintenance, operation, interest and amortization will amount to $1,373,000.

Review of Existing Situation.

The territory tributary to Jamaica Bay comprises two distinct areas separated by the bay itself, Nassau County at the eastern end and the strait known as Rockaway Inlet forming the connection between the bay and the Atlantic Ocean at the western end. Roughly speaking, the northerly area covers 65 square miles, the southerly area east of Seaside Park 5.5 square miles, and the bay 28 square miles.

The resident population on this area in 1915 was 436,000, to which there should be added a considerable number of persons who live in bungalows on the islands during the summer and the crowds who go to the Rockaway beaches and Canarsie for bathing and amusement. The territory comprising Flatbush and East New York is already well built up, but population densities are increasing over the entire area, especially in the Flatlands and Jamaica sections, so that by 1960 a resident population of 2,500,000 may be expected.

Now this is a population greater than that of Berlin, Tokio, Petrograd or Vienna, and, if we except New York itself, is only exceeded at the present time by the cities of London, Paris and Chicago. When we consider that Jamaica Bay has a mean depth at low tide of less than 5 feet and no replen-

ishment of its waters except that due to tidal oscillation the importance of the question of sewage disposal becomes apparent.

It is estimated that within the next 40 years the sewage produced in the area will approximate 300,000,000 gallons per day, and in planning for the disposal of this enormous volume the future uses to which the bay will be put are of prime consideration.

Jamaica Bay itself is landlocked, connecting with the Atlantic Ocean by way of Rockaway Inlet only and without any inflowing fresh water feeders of consequence. Its waters cover an area at high tide of 21½ square miles, exclusive of 6 square miles of low marshy islands.* The area at low tide is 17¼ square miles. At mean tide it is about the size of New York Upper Bay. The shores are low and flat, the marsh lands bordering the bay comprising (according to the Jamaica Bay Improvement Commission) over 13 square miles. The shore line is 294 miles in extent.

The tidal range varies at different points, but averages about 4.3 feet. The tidal prism, or the volume passing through the Inlet with each flood and each ebb tide, amounts to 2,308,710,000 cubic feet, and it is this volume, replenished twice a day, that is available for the dilution of sewage.

The volume remaining in the bay at times of mean low tide is 2,258,050,000 cubic feet, or an amount practically equal to the tidal prism. In other words, at times of high water the bay contains twice as much water as at times of low water.

The bay is, therefore, shallow, averaging but 4.7 feet in depth at times of low water, but the channels which spread out over its area from the Inlet vary in depth, reaching extreme depths of:

66 feet at one place in Big Channel, east of Barren Island;
32 feet in Beach Channel, south of Ruffle Bar, and
47 feet north of Rockaway Point.**

The net ebb current, or excess flow to the ocean, due to the inflow of upland or surface water, is very uncertain, but has been computed at 24,000,000 cubic feet for each cycle of the tide.

The current velocities in the bay are generally low and influenced by the wind. Experiments made in 1909 by the Metropolitan Sewerage Commission between Rockaway Point and Point Breeze, with submerged floats, indicated a maximum channel velocity on the flood current of 2.1 feet per second and on the ebb current of 3.4 feet per second. (Plate I.) These velocities, with the increased scour due to the higher velocities during spring tides, are sufficient to maintain depths of from 30 to 40 feet in the channel, but in the interior of the bay the velocities are too low to prevent the formation of deposits from raw sewage or storm water.

Float experiments made by the Jamaica Bay Improvement Commission

*These areas and volumes assume the western limit of the bay as opposite the angle of the existing bulkhead on Barren Island south of Dead Horse Bay. For purposes of general discussion in this report it is assumed to extend to Dead Horse Inlet, about 3,000 feet to the west.
**U. S. C. & G. S. Chart 342 corrected to 1909.

CURRENTS IN CHANNEL AT ROCKAWAY INLET
TAKEN AT 0.2 AND 0.8 OF DEPTH

CURRENTS IN CHANNEL AT ROCKAWAY INLET
TAKEN AT 0.2 AND 0.8 OF DEPTH
SEPT 28TH TO DEC 3RD
1909

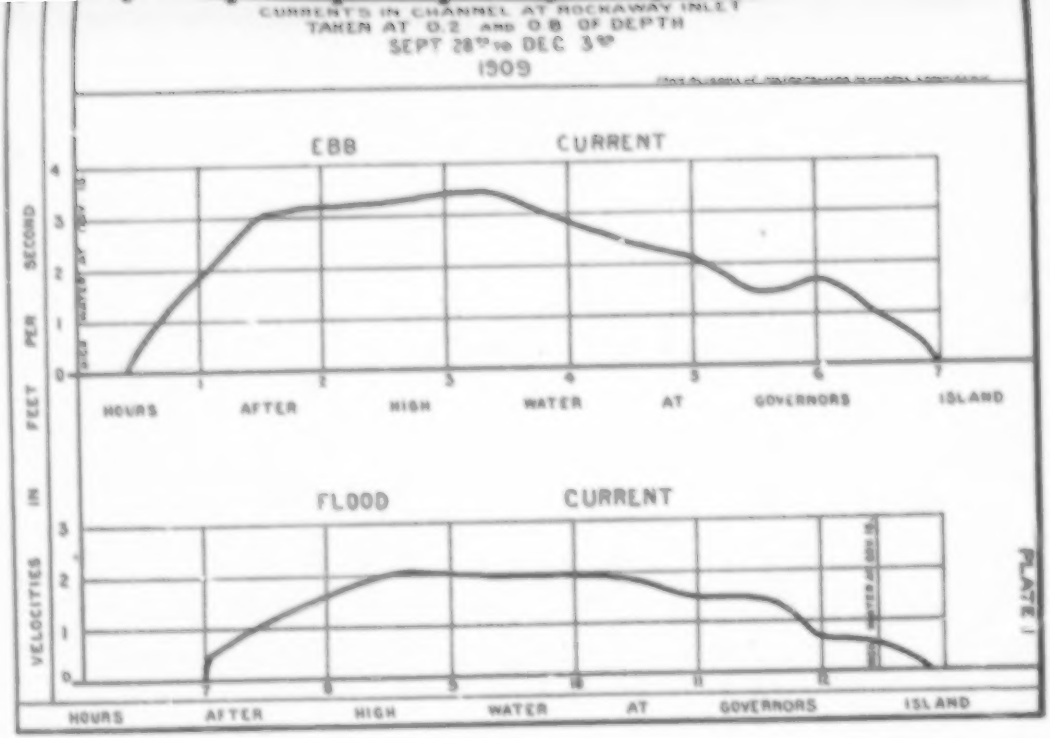


PLATE I

in December, 1906, and January, 1907, showed that flood velocities may reach 2.7 feet per second and ebb velocities about 4 feet per second at the Inlet; and ebb velocities 2.5 feet per second in Big Channel and from 3.0 to 3.5 feet per second in Beach Channel. (Plate II.)

Any plan contemplating a discharge of sewage into Rockaway Inlet should take into account the changes that are occurring and likely to occur in the future in the channel to the sea. Rockaway Point has extended westerly a distance over 3 miles in the past 79 years, or about 239 feet per year* by the deposit of sands eroded from the southerly shores of Long Island. The building up of material toward the west is probably due in part to a general littoral drift in that direction, due in particular to the fact that the maximum wave action takes place from the east. If this westerly growth continues indefinitely, Coney Island itself will eventually be brought into the confines of the bay. This is quite uncertain, however. There is a bar with a depth of from 1 to 7 feet of water at low tide, concave toward and just west of Rockaway Point, which definitely diverts the ebb current to a southerly direction, and thus tends to erode any deposit received from the bay itself that would otherwise form and sweep it off shore. The trend of this current is clearly indicated by float experiments made by the Corps of Engineers, U. S. A., in December, 1908. (Plate III.) If left to natural agencies experience along the Long Island shore teaches that the extreme point will be cut off, sooner or later, at the weakest place, probably west of Neponsit, forming a new inlet, and the terminal island which will be left may either survive, join the mainland, or be washed away in storms. The important point to note is that *the discharge from Jamaica Bay is likely to persist in a southerly direction without affecting the waters of Coney Island.* Once at a sufficient distance from shore to be brought within the influence of the discharge of the Hudson River from the Narrows it will be more positively directed toward the open ocean. To quote the Jamaica Bay Improvement Commission:**

Through the Narrows there pass out on the ebb all the waters of the Upper Bay which have entered from "the Hudson River, part of the East River, the Raritan, Rahway, Passaic and Hackensack rivers, so that at the very moment that the waters of Jamaica Bay begin to ebb in a direction somewhat south of west they encounter this immense body of water from the Narrows, and, naturally, at the earliest opportunity after being released, they turn, join the main body and pass out to sea."

In the past, Jamaica Bay has been noted as a source of supply for oysters and clams which find in its shallow waters conditions favorable to their growth. This industry has become of sufficient importance to require serious consideration in any plan affecting its continuation, as indicated by the follow-

*Improvement and Protection of Coney Island Shore and Construction of Proposed Boardwalk. Charles R. Ward. The Municipal Engineers' Journal, September, 1916, p. 105-23.

**H. R. Doc. No. 1506. 60th Congress, 2d Session, 1909, p. 21.

ing figures furnished by Mr. Harold Keen, of the New York City Department of Health.

At the present time from 750,000 to 1,000,000 bushels of seed oysters, costing the grower 60 cents per bushel, are planted annually and subsequently taken from the waters of the bay and later sold at from 95 cents to $1.10 per bushel, making the total receipts about $1,000,000.

In round numbers there are also planted 300,000 bushels of hard clam seed, costing $3.30 per bushel of 6,000 clams. These increase tenfold during the year (the past year but six or sevenfold) when they bring at 800 clams per bushel, about the same price, or $3.33 per bushel.

Soft or "steamer" clams, unlike the hard clams and oysters, grow naturally in Jamaica Bay and are taken in large numbers from their beds without cultivation. Information regarding this industry, which is carried on by anyone, without the leasing of beds, is less reliable than regarding the oyster and hard clam fisheries, but there are probably an average of 350 men employed in the business for nine months of the year. Allowing three bushels gathered by each man, the total daily amount will be about 1,000 bushels, or, for nine months, 270,000 bushels. As these bring about $1.25 per bushel, the value of the product is probably about $335,000 annually.

Altogether nearly $500,000 is invested in the oyster industry and twice that amount in that of hard clams. The permanent equipment of these fisheries is estimated at from $100,000 to $125,000 and the total value of investments at from $1,500,000 to $2,000,000. They furnish employment for some 1,500 persons, and their value as an asset to the City is said to amount to some $5,000,000 per annum.

Owing to the large proportion of Jamaica Bay which is barely inundated at low tide it will probably never be popular for yachting purposes, but already the islands lying near the railroad crossing to Hammel, between Broad Channel and The Raunt, attract a very considerable number of persons who spend their summers boating, fishing and bathing in the neighboring waters.

In December, 1909, the Jamaica Bay Improvement Commission presented a report recommending the development of the bay for commercial purposes by dredging a channel around its margin, constructing bulkheads and filling in the marsh land behind. This proposition met with general approval and, beginning at the ocean entrance in August, 1912, the work as far as Fresh Creek has been carried out conjointly by the Federal Government and New York City so far as to provide an 18-foot channel 500 feet wide, with the adjacent bulkheads and filling.

The future development of the bay depends largely upon the prosecution of this work. Already several large industrial plants have been established on Mill Basin between Flatlands and Barren Island. If carried out as planned Jamaica Bay will in time become the port of entry for a considerable

amount of domestic commerce and have a large population with warehouses and factories along its northern shore.

The Commission's plan comprises the construction of a number of arms or basins running back from the main channel and bulkhead line to provide docking facilities. These vary from less than a mile to about two miles in length. Incidentally, they constitute an important factor in the main drainage of this territory. In the first place, in order to avoid a series of inverted siphons in a line of intercepting sewer, the latter must be located between one and two miles from the main bulkhead line; but a more important factor is their relation to the storm water drainage, enabling storm sewers to outlet at their upper ends and so permitting better gradients than if extended to or beyond the present shore line.

The sanitary feature of these basins should not be overlooked if they are to be maintained in a satisfactory condition. A large amount of foul street wash will inevitably find its way to them in addition to the refuse carelessly dropped in from vessels and docks. Measures should be taken to keep the amount of such material at a minimum and for its regular removal.

Another feature of the Commission's plan was the construction of interior islands, according to some definite design, by the necessary bulkheading, dredging and filling.

Indeed, within the past few weeks a large area along the crossing of the Long Island Railroad, from Ramblersville to Hammel, has been leased for a term of 30 years to a company for development, with provision for a sanitary disposal of the sewage.

Developments of this kind not only bring in an added population to pollute the waters of the bay, but by increasing the depth of the channels and reducing the surface area of the bay the ratio of the tidal prism (or volume between high and low water) to the volume below low water is reduced. In other words, the dilution, which is measured by the proportion of clean water brought in during each flood tide to the polluted water already in the bay, is diminished, so the resulting dilution will be less—perhaps far less—than under existing conditions.

If the 300,000,000 gallons reaching the bay in the future were uniformly dispersed throughout its waters under present topographical conditions the resulting dilution—111 to 1—would be sufficient to avoid a nuisance. This ratio would be reduced to an unknown extent by the proposed improvement*, as explained above, but any estimate based upon the assumption of a uniform dilution is without value. The discharge of sewage is at local points and into waters with very little current, so that the actual dilution at these points is already so meager that offensive conditions exist. This is particularly the

*If, for instance, the minority plan proposed in 1907 by the Jamaica Bay Improvement Commission were carried out, the islands now in the bay would be replaced by two islands whose combined area would reduce the water surface by about four square miles, the tidal prism above the Barren Island outlet by 477,000,000 cubic feet, and the future ratio of dilution to 1:88, a reduction of 21 per cent.

case near the mouths of Paerdegat Creek, Second Creek (receiving the 26th Ward effluent) and Bergen Creek (receiving the Jamaica effluent).

NECESSITY FOR REMEDIAL MEASURES.

From the general situation as described it will probably be conceded that steps should be taken to protect Jamaica Bay from further pollution and to abate such nuisances as already exist.

It may be taken for granted that with a large population surrounding the bay, inhabiting its islands and navigating its waters there will always be a residual defilement of the latter that it is impossible to prevent, and it has already been decided by the United States Bureau of Chemistry to prohibit the use of important layings as a direct supply of shellfish to the market between April 15th and December 1st, and this ruling has been concurred in, pending future investigations, by the New York State Conservation Commission. This being the case, the public will require evidence that further preventive measures are necessary before expending any considerable sum of money for the purpose.

Aside from the question of shellfish contamination, it may be said that pollution of the bay may be objectionable on account of:

a. The formation of deposits on the bottom.
b. Putrefactive conditions in the water.
c. The unsightly appearance of the water, due to turbidity, scum or sleek.
d. The effect on fish life.
e. The possible danger of infection to bathers.

Evidences of pollution of the bottom of Jamaica Bay were obtained in June and July, 1909, by the Metropolitan Sewerage Commission in the vicinity of Arverne, Second Creek, Fresh Creek and Canarsie.* In all, out of 20 samples of material dredged, 9 were polluted and 5 doubtful. The opinion as to a sample was based upon its color, consistency, bacterial content and microscopical evidence. It was shown that deposits of putrescible material are to be found over certain areas of the bay.

The deposits which occur near the existing sewer outlets will naturally increase in depth and extent to the detriment of navigation and to the quality of the overlying water besides producing objectionable odors in increasing quantity at times of low water.

To prevent the continuation and increase of this condition *the solids brought down in the sewage should be removed as completely as practicable. As this can be accomplished most effectively by the use of grit chambers and tanks or fine screens the entire sewage of this area should in the future be treated by one or more of these devices* and the plans prepared have been outlined on this assumption.

*Rep. Metropolitan Sewerage Commission, 1912, pp. 197, 198.

Evidence concerning the polluted character of the waters of the bay—especially along the shore—has been obtained by inspections, determinations of the dissolved oxygen and by examinations for bacteria.

The principal sources of pollution are as follows:—

Locality	Effluent from	Million Gallons per Day (Approximate)
Shellbank Creek	Caisson No. 4	1.5
Paerdegat Creek		8.0
Second Creek	26th Ward Plant	25.0
Bergen Creek	Jamaica Plant	3.0
Nigger Bar Channel	Far Rockaway Plant	1.0

Added to these there are many points on both sides of the bay polluted locally either directly or by sewer outlets along the shores, so that the entire amount may be provisionally considered as equivalent to 50 million gallons of sewage per day.

According to Dr. Payne B. Parsons: "Hundreds of cottages at Broad Channel, The Raunt, Goose Channel and Ramblersville pollute the bay from overhanging privies. Numerous cottages at Sand Bay, Bergen Creek, Cornell Creek, Old Mill Creek and at other points also contribute to the pollution from privies which discharge into the bay or into the marshes which drain into the bay."

"All through the warm season, particularly on Sundays, the bay is frequented by fishermen in small boats, who add to the pollution."

It is understood, however, that certain of the conditions enumerated by Dr. Parsons are to be remedied by improvements to be made in the near future.

In October, 1909, inspections were made by John P. Fox of the waters of the bay, especially in the vicinity of sewer outlets. The following are extracted from his report:—

Paerdegat Creek—"Mud near mouth of creek had an odor when left bare by falling tide, increased by digging. . . ." "With flood current, no effluent was found issuing at the regular outlets . . . With ebb current, the whitish water from the creek was found flowing southeast in a well defined stream, perhaps two hundred feet wide, by Bergen Beach, with clearer water inshore from the stream as well as outside. The sewage was inside the two piers at Bergen Beach, and the yachts were moored in it. Odor was noticed as far as Bergen Beach, coming from the stream."

Second Creek—"Effluent was very turbid, full of white particles, and with very strong odor . . . The sewage was found flowing out of the flume during both flood and ebb currents. The water of the bay with flood current moves north-east here along the shore, and the sewage was found extending in a narrowing belt a mile away to the mouth of Old Mill Creek, the day being calm, and the smooth film of the sewage continuous. The southern edge of the film was bounded by a line of reddish scum, thickest off

Second Creek, where many particles were suspended in the water, especially white ones. Odor was noticed as soon as one rowed inside the line of scum."

Bergen Creek—"Eel grass in water of branch creek was all covered with whitish deposit . . . Near mouth of main creek there was no mud on center of bottom, but was found on sides, giving off bubbles when stirred."

Far Rockaway—"Artificial channel to disposal plant at near high water was turbid and whitish in color."

In June, July and September of the same year bacteriological examinations of 36 samples of the water were made.* The number per c. c. varied from 1,600 two hundred feet off Barren Island to 1,000,000 at the head and 800,000 at the mouth of Second Creek. Other high counts were 280,000 and 12,000 five hundred feet off the mouth of Second Creek, 40,000 one thousand feet off the mouth of Second Creek, 36,000 one thousand feet off the mouth of Fresh Creek, and 22,000 five hundred feet off Sand Bay Shore.

In the period between Nov. 13, 1912, and Jan. 14, 1913, the Bureau of Sewers of Brooklyn made bacteriological examinations of samples of water taken from various points in Jamaica Bay at different stages of the tide and plated in agar at 37 degrees C, with the following average results:—

In 1904 21 cases of typhoid were traced by Dr. George A. Soper to oysters floated at Inwood near the head of Jamaica Bay.

Following the outbreak of an epidemic of typhoid fever in 1911 investigations were made by which it was shown that not only 27 cases of typhoid but 99 cases of gastroenteritis (diarrhoea) in addition were caused by "Rockaway" oysters, obtained at Canarsie, which were "dangerously polluted."—†

In 1908 the State Department of Health made a careful examination of the pollution of Jamaica Bay as related to the oyster industry‡ and the subject is reviewed by Theodore Horton, Chief Engineer, in the report of the Department for 1914.§ Mr. Horton says:—

> "Much has been said regarding the retaining or reclaiming of these waters for oyster growing by the construction of intercepting sewers and sewage disposal plants; also of the possibility of using these grossly polluted waters for oyster propagation and of later transferring the seed or partially grown oysters to other grounds not so polluted for maturing and purging. The first of these is impractical from the standpoint of efficiency of operation and of pro-

*Report Metropolitan Sewerage Commission, 1912, pp. 343, 355.
†Bulletin No. 156 U. S. Dept. of Agriculture, Bureau of Chemistry, 1912.
‡Report State Department of Health, 1908.
§Vol. 2, Page 463, et seq.

> hibitory expense to obtain safe effluents. The second is impractical on the grounds of difficulty of administration or supervision over the oyster industry and the secondary danger of transference of polluted waters and muds to clean waters, where these waters will in consequence become in turn contaminated. . . .
>
> "In other words no point of a bay of moderate area into which sewage is discharged is free from intermittent contamination, carried to it by the chance components of tidal and wind-induced currents; and as a corollary any oysters located at any point in the bay will receive the accumulated sewage deposits from the sewage thus intermittently carried to them."

In conclusion Mr. Horton recommends that no certificate to owners, lessees or possessors of grounds in Jamaica Bay from which shellfish are taken or upon which they are cultivated shall be granted in the future.

In the same year the Bureau of Chemistry, Department of Agriculture, made extended studies of the subject, including the examination of 151 samples of oysters and 7 samples of clams taken from Jamaica Bay, besides samples of its waters, for evidences of contamination by the presence of the Colon bacillus.

Of these, 64 of the samples gave scores of from 50 to 500 indicating contamination.*

The following are extracted from the report of Dr. Fayne B. Parsons who conducted the investigation:

> "With the exception of certain creeks in the western and eastern sections of the bay, the water contained colon bacilli in at least 1 c.c. amounts at some stage of the tide. . . . In many sections of the bay the water contained 1/10 of a c.c. and oysters from these areas would unquestionably have a prohibitive score in the summer time.
>
> "Oysters taken from Jamaica Bay during the summer season were found almost invariably to have scores above 50.
>
> "Colon bacilli were rarely found in 1/10 dilutions of the shell liquor and were never present in the 1/100 dilutions and the standard of 50 was never exceeded in the case of oysters taken up from December 1 to the middle of April."

*As recommended by the Am. Public Health Association: "The score or rating . . . is calculated by adding the reciprocals of the highest dilution in which *B. coli* has been found in the shell liquor of the five oysters which form the specimen. Thus, in the shell liquor of five oysters separately examined, *B. coli* has been found in three in 0.1 c.c. dilution and in two in the 1.0 c.c. dilution. The reciprocals are 10, 10, 10, and 1. 1. and their sum is 32—the rating." U. S. Hygienic Laboratory Bulletin No. 104.

As a result of these investigations the Federal Government has prohibited the shipment of oysters from these waters:

> "from April 16th to November 30th, unless they have been transplanted to an unpolluted area and allowed to remain there for a period of at least seven days and found upon subsequent examination to have purified themselves to such an extent that they have an allowable score. Nothing herein contained, however, shall be construed as permitting the shipment of oysters scoring over 50."*

On November 6th, 1915, a certain lot of oysters was seized by the Bureau of Chemistry, U. S. Department of Agriculture, after an examination of samples scoring 500, 500, 500, 320, 230 and 140 and suit brought in the U. S. District Court.** The result of this trial has been the adoption by the State Department of Health of the above ruling of the Federal Government with regard to the sale of oysters.

These oyster investigations are referred to here as furnishing evidence of bacterial contamination of Jamaica Bay rendering it, as a whole, unfit for shellfish culture or bathing, the continued practice of which would have an important bearing on the question of sewage disposal.

Aside from bacterial pollution the waters in the vicinity of Paerdegat Creek have recently been rendered unfit for oyster culture by the discharge of dye wastes into that stream. The New York City Department of Health has, therefore, until further investigations are made, prohibited the sale of oysters grown in the sections of the bay known as Bergen Beach, the mouth of Fresh Channel, Island Channel and the lower end of Big Channel unless transplanted under the supervision of the Department, or, if shipped beyond the City limits, the proper local authority. The area affected lies within about two miles of the mouth of Paerdegat Creek.

*It is understood that a small area in Hassock Creek is exempted from this ruling. K. A.
**U. S. vs. 408 bushels of Oysters, Jury Trial, March 6—16, 1916.

TABLE I.

Bacteria in Jamaica Bay.

Location	Number of Samples	Bacteria per c. c. Max.	Min.	Ave.	% Positive B. Coli. in .001	.01	0.1	1.0
Just below L. I. R. R. bridge, 1000 ft. from (north) shore	3	230	5	90	—	—	33	67
Mouth of Old Mill Creek	5	8500*	170	3000	60	67	100	100
Half-way across Chan. opp. Old Mill Creek	4	160	22	70	—	—	50	75
North of Second Creek	5	500,000	3,000	130,000	75	100	100	—
Half-way across Chan. opp. Second Creek	5	300	14	160	—	—	20	80
Just off Canarsie Landing	5	7300	1400	3000	00	100	100	100
Half-way between Canarsie Ldg. and Gov. Breakwater Lt.	4	1100	110	530	—	—	100	100
Off Bergen Beach Landing	4	11,500	200	3400**	—	33	100	100
Mouth Spring Creek	1	—	—	1800	—	—	100	100
Mouth Paerdegat Creek	1	—	—	540	—	—	100	100
Mouth Hawtree Creek	1	—	—	90	—	—	100	100
Mouth Indian Creek	3	9000	100	4000	00	100	100	—
700 ft. S. W. of Landing at Ruffle Bar	5	75	6	29	—	—	00	80
3000 ft. S. of Mouth of Duck Creek in Big Fish Channel	2	70	14	42	—	—	00	100
600 ft. S. E. of light on Gov't. Breakwater	5	325	18	100	—	—	40	100
Island Chan. at Mouth of Irish Creek	2	75	30	65	—	—	50	100
Lower end of Island Channel	2	300	300	330	—*	—	00	100

*Strong wind stirs bottom.
**This average excludes the maximum figure.

The best indication of an approach to an objectionable or putrescible condition of the water is the percentage of saturation of dissolved oxygen. The general results of analyses for this in the open water of the bay are given in the following table:

TABLE II.

Dissolved Oxygen in Jamaica Bay.

a. Results obtained by the Metropolitan Sewerage Commission and the City of New York.

Date	No. of Samples	Location	Current	% Saturation	Authority
June 29, 1909	6	Rockaway Inlet	Ebb	93	Met. Sew. Com.
" 29, "	8	Belle Harbor to Norton's Creek	Flood	89	" " "
" 30, "	2	Far Rockaway to Arverne.	"	68½	" " "
" 30, "	2	Arverne	Ebb	80	" " "
July 1, "	4	Off Fresh Creek	"	33	" " "
" 1, "	3	Near Canarsie	Flood	75	" " "
" 1, "	6	Rockaway Inlet	"	111⅛	" " "
Sept. 7, "	4	" "	Ebb	81	" " "
" 7, "	8	Ruffle Bar to Canarsie	"	74	" " "
" 4, "	4	Off Fresh and Second Creeks	"	45½	" " "
Sept. 8, 1913	4	Rockaway Inlet	Flood	88	ur. of Sewers, Manhattan
" 8, "	3	Off Canarsie	"	51	" " "
" 8, "	2	Beach Channel	Ebb	91½	" " "
May 19, 1915	2	Off Second and Old Mill Creeks	Flood	53½	Bur. of Sew. Plan
" 19, "	6	Grassy Bay, Broad Channel & Big Mucks Creek	Flood	91	" " "
" 19, "	1	Arverne	Ebb	70	" " "
" 19, "	7	The Raunt, Big Fishkill Creek, Big Channel	"	98	" " "
Aug. 20, "	2	Off Bergen Beach and Island Channel	"	66	" " "
" 20, "	9	Rockaway Inlet to Hassock Creek	Flood	82	" " "

PLATE IV
LOCATION OF
DISSOLVED OXYGEN SAMPLES
TAKEN BY U.S. PUBLIC HEALTH SERVICE
IN JAMAICA BAY
1916

b. Results obtained by the U. S. Public Health Service Aug. 11-18, 1916. (See Plate IV.)

Location	Current approaching end of	Saturation Per Cent* Sample A	Saturation Per Cent* Sample B
Beach Channel			
1. Neponsit	Ebb	64	71
	Flood	90	87
2. Belle Harbor	Ebb	56	68
	Flood	92	75
3. Seaside	Ebb	67	74
	Flood	90	63
4. Holland	Ebb	66	66
	Flood	84	101
5. Brant Point	Ebb	66	65
	Flood	101	90
6. Black Point	Ebb	84	90.5
	Flood	95	108
Grass Hassock Channel			
7. Grass Hassock Bar	Ebb	55	66
	Flood	105	95
8. Green Point	Ebb	65	—
	Flood	99	—
Nigger Bar Channel			
9. Mouth	Ebb	62	54
	Flood	110	104
10. Nigger Bar	Ebb	90	81
	Flood	118	108
11. Electric Chimney	Ebb	44	34
	Flood	127	99
12. 303 yds. below outlet	Ebb	47	20
	Flood	101	71
Bass Channel			
13. Head	Ebb	74	66
	Flood	66	64
Big Channel			
14. Head	Ebb	—	47
	Flood	125	121
15. Outlet 26th Ward Sewer (Second Creek)	Ebb	73	78
	Flood	—	—
16. Canarsie Breakwater	Ebb	36	35
	Flood	94.5	91.5
17. Old Swale Marsh	Ebb	62.5	18.5
	Flood	95	89.5
18. Barren Island Chimney	Ebb	43	54
	Flood	97	89
Island Channel			
19. John Pt. Marsh	Ebb	75.5	54
	Flood	119	93
20. Bergen Beach	Ebb	19	24
	Flood	99	86
21. Canarsie Landing	Ebb	0	0
	Flood	92	88
Dead Horse Inlet			
22. Plumb Beach Channel	Ebb	67	77
	Flood	97	93

*Deduced from data furnished by Dr. Hugh S. Cumming, Surgeon in Charge, Investigation Coastal Waters.

These averages are seen to vary from figures showing supersaturation at various points during the flood tide to 81 per cent. at Rockaway Inlet, 47 per cent. in Big Channel, 19 and 35 per cent. off Bergen Beach and Canarsie, 33 per cent. off Fresh Creek, 20 per cent. in Nigger Bar Channel, 30 per cent. off Arverne; 56 per cent. off Belle Harbor, and 64 per cent. off Neponsit during the ebb. Results near the discharge from sewers would, of course, have been much lower. In general the figures indicate excellent conditions in the channels near Rockaway Inlet, but becoming worse and worse in ascending Big Channel along the northerly shore or Beach Channel along the southerly shore until we find the present saturation quite as low as should be permitted if we wish to avoid local objectionable conditions. With an increasing tributary population and a reduction in the tidal prism due to filling in to the bulkhead line a rapid lowering of the saturation figure in warm weather may be expected in the future.

To prevent the formation of odors that would result from the putrefactive conditions following a material depletion of the dissolved oxygen, sewage discharged into the bay more than 2 or 3 miles above Rockaway Inlet should, besides the removal of suspended matter, be subjected to some oxidizing treatment, such as filtration or direct aeration, that will render the effluent reasonably stable.

Owing to recent developments in the art of oxidizing sewage which, although promising well, are yet in progress, no specific method for adoption is recommended in the plans, but there are already well known standard methods the cost of which may be here considered as a maximum, with a prospect of a reduction if the investigations referred to are brought to a favorable issue.

The two kinds of treatment mentioned should prevent, as well, any appearance of the effluent suggestive of its origin or that would be otherwise offensive. In general the bay should be kept in a condition favorable to the preservation of fish life. There remains, then, the question of using the bay for bathing purposes. The conditions requisite for this are similar to those for the cultivation of oysters and clams. Bacterial contamination will render the water unfit for either purpose; and as it has been shown to be unsafe for the culture of shellfish, so Jamaica Bay is considered unsuitable for bathing whether the sewage is treated or not. Even if the effluent were chemically disinfected the chance contamination from other sources would in the future be too great to consider the waters of the bay sufficiently clean.

To sum up, *if the greater part of the suspended solids are removed from the sewage and the liquid portion entering the interior of the bay is oxidized so as to produce a reasonably stable effluent, the waters will be unobjectionable from any point of view with the exception of oyster culture and bathing, which latter should in any case be discontinued in these waters.*

The question arises here why so large an amount of pollution should

be caused by the effluent of the four existing treatment plants. The plants were built some twenty years ago under the "Powers" patent. The treatment originally consisted in the addition to the sewage of lime and perchloride of iron as precipitants and chlorine gas as a deodorant. The plants were long ago outgrown, but appear never to have furnished an effluent comparable with such precipitation plants as, for example, those at Worcester and Providence. Nearly ten years ago Dr. D. D. Jackson stated with regard to the largest of them—that for the 26th Ward, Brooklyn —"The process of purification has not materially reduced either the suspended matter or matters in solution," while the following May (1908) the Chief Engineer of the Bureau of Sewers said: "I believe that chemical treatment should be entirely done away with at East New York" (the 26th Ward plant). The results at the other three plants are much the same. As to the foulness of their effluents to-day there is no question.

A chemical precipitation plant properly designed and operated will remove 85 to 90 per cent. of the suspended solids and produce a clear sparkling effluent, but as the latter is liable to subsequent decomposition and as the costs of operation are high there is no reason to consider such treatment in any permanent installation in the Jamaica Bay area.

Other Investigations for the Main Drainage of the Area Tributary to Jamaica Bay.

The treatment of the drainage of Southern Brooklyn and Queens has been the subject of discussion and controversy for a number of years. It has been studied carefully by the local Bureaus of Sewers, by the Metropolitan Sewerage Commission and by the Board of Estimate, including W. M. Black and E. B. Phelps, the New York Sewer Plan Commission and the Bureau of Sewer Plan.

It has been particularly difficult to decide upon the adoption of any one plan as the problem may be effectively solved in a great variety of ways, one of which seems best to each authority according to the emphasis placed upon different features, such as the points of outfall, method of treatment, limiting distance to bring sewage for treatment, location of pumping stations, the separation of storm water, etc., etc.

It has been the intention to give careful consideration to the several points of view as expressed and to arrive at a result that will not only be efficient and economical in the true sense of the words but one that will be acceptable.

In June, 1914, the Borough of Queens prepared a plan* for collecting the sewage from the northwest of Freeport Avenue and Springfield Road to the Jamaica Disposal plant and that from east of Sapphire Street and north of Egan Street to the same point by an interceptor.

*Letter of J. Franklin Perrine, Engineer of Design, to Foster Crowell, Consulting Engineer.

More recently, as stated in the letter of transmittal of this report, the Borough has outlined a scheme for draining some 3,500 acres lying northerly from Baisley's Pond by the combined system, discharging the storm flow to Cornell Basin and intercepting the dry weather flow to the Jamaica disposal plant. This proposition, which will be taken up in more detail later, was the occasion for the preparation of this report.

The Borough of Brooklyn has given careful study to the question and is continuing these investigations in connection with the experiments on sewage treatment which are being made at the Twenty-sixth Ward Disposal Plant. It is understood that no definite conclusions as to lines of interception and points of disposal have been reached as yet, but a plan was worked out in 1913 for the interception of much of the sewage of Queens to the Twenty-sixth Ward plant at Hendrix Street. The interceptor in this case ran from the Rocky Hill Road and Jericho Turnpike to New York Avenue and Bergen Turnpike, to New York Avenue and Bergenfields Street and thence around the southerly end of Baisley's Pond, crossing the Aqueduct and the Long Island Railroad near their intersection, thence along Cozine Avenue to the 26th Ward disposal plant.

Meanwhile, between 1910 and 1914, various plans for the collection and disposal of the sewage tributary to Jamaica Bay had been studied by the Metropolitan Sewerage Commission* and estimates made for 12 of these. One of the chief aims in these studies was to determine the most advantageous points of outfall and in this respect the following were selected as particularly satisfactory:

New York Lower Bay 3 mi. off Coney Island.
Atlantic Ocean 8,000 ft. off Rockaway Point.
Atlantic Ocean 4,000 ft. off Edgemere.
Rockaway Inlet
Big Channel, Jamaica Bay.
Beach Channel, Jamaica Bay.
Broad Channel, Jamaica Bay.

November 18, 1910, a report on the sewerage of the Jamaica Bay Drainage District was made by Col. W. M. Black and Prof. E. B. Phelps to the Board of Estimate.** By the plan proposed the sewage from Paerdegat and Caisson No. 4 was to be carried to Barren Island and discharged into Rockaway Inlet; that from the Twenty-sixth Ward plant would be discharged into Fishkill Channel; and that from the Jamaica plant into Broad Channel. On the south side the sewage from Far Rockaway and the Rockaway peninsula would be brought to three concentration points and carried to submerged outlets 1,000 feet off shore in 15 feet of water. The plan provided for the fine-screening and a brief settling of sewage dis-

*Report Metropolitan Sewerage Commission, 1914.
**Report Col. W. M. Black, U. S. A., and Prof. E. B. Phelps concerning Location of Sewer Outlets and the Discharge of Sewage into New York Harbor, 1911.

charged into the ocean and for the screening and oxidation of that entering the bay.

Early in 1913 a plan was prepared by the Brooklyn Bureau of Sewers for an intercepting sewer from Rockaway Parkway along Flatlands Avenue, Ralph Avenue, Avenue T and Flatbush Avenue to Barren Island, providing for the sanitary sewage from about 9 sq. mi. of territory. The problem of taking care of the increasing flow into Paerdegat Basin was already pressing.

This plan was referred to the Board of Estimate and a modification was suggested involving the inclusion of Caisson No. 4 into the scheme, the omission of a pumping station near Mill Basin and the adoption of the combined system for areas draining to points below Paerdegat. As a consequence the lift at the pumping station proposed at the head of Paerdegat Basin would be increased and the street grades of streets draining to the interceptor below the Paerdegat pumping station would be raised. The matter was then referred to the Sewer Plan Commission and reviewed in a preliminary memorandum dated March 23, 1914, giving comparative estimates favoring the plan originally proposed. These estimates were later revised* indicating no great difference in first cost between the two schemes but lower annual charges in the Board of Estimate's plan, the essential points at issue being the employment of the separate system and a discharge after screening without pumping below Paerdegat. There are merits in either contention, but it is believed that the preference will depend largely upon the area drained to Barren Island and on the method of treatment deemed necessary at that point.

Controlling Considerations.

The selection of points of outlet depends partly upon the present system of sewers, the majority of which concentrate at the following points:

Caisson No. 4 on Shell Bank Creek,
The head of Paerdegat Basin,
The Hendrix Street Disposal Plant near Second Creek,
The Jamaica Disposal Plant near Bergen Creek,
The Far Rockaway Disposal Plant at the head of Nigger Bar Channel.

Secondly, it depends upon the tidal prism of that part of the bay available to dilute the effluent and carry it toward the ocean on the ebb current.

Lastly, it depends on the proximity to favorable sites for treatment and on the character of the future development of the neighboring territory. Treatment plants, however inoffensive, should as a general principle be located as far as possible from well developed or high class property.

Bearing all these matters in mind there are three sites that have been

*Memorandum concerning Flatbush Avenue Trunk Sewer and Outlet, Bureau of Sewer Plan, February 5, 1915.

selected as being most favorably located to receive sewage effluents in large volumes, provided they are suitably treated before discharge, and in the vicinity of which such treatment may be applied without offense or objection.

The most favorable of these is Rockaway Inlet between Barren Island and Rockaway Point. Under present conditions works placed on Barren Island would be far from any population except those persons who have heretofore found employment in the garbage reduction plant at this point. Transportation facilities by water are good and by land may be made so by the extension of Flatbush Avenue south of Avenue U. Good currents and depths of water of from 30 to 50 feet are available for the dispersion of the effluent, and as the ebb current will carry it out into the ocean with a trend off shore toward the southeast, little more than half the volume discharged at this point will remain to pollute the waters of the bay through which it will be thoroughly dispersed.

The waters of Beach Channel and The Raunt just below Little Egg Marsh offer favorable conditions for disposal. Depths of from 20 to 40 feet are available and, while most of the effluent discharged here will pass out to sea on the ebb current, the flood will carry the remainder up these channels to the interior portions of the bay.

The third favorable point for an outlet is in Broad Channel or Hassock Creek west of Jo Cos Marsh. Here depths of from 10 to 18 feet are found, with fair currents toward Rockaway Inlet on the ebb and away from the mainland shores on the flood.

At all these points land now owned by the city is available for treatment purposes and the population for a considerable distance is scattered.

In addition to these three selected points there are others in the interior of the bay and possibly on the shores where a well operated plant with a discharge into a good channel might be unobjectionable.

As we approach the easterly end or "head" of the bay the influence of the tides in replenishing the polluted water becomes less and there is practically no inflow of upland water to offset this disadvantage. It is therefore evident that sewage discharged at this end of the bay will have to be more thoroughly treated to avoid putrefactive conditions than if discharged near Rockaway Inlet, and it has been assumed that such sewage should be subjected to some sort of oxidizing treatment in addition to the removal of the coarser solids.

Near Rockaway Inlet, however, with nearly half the effluent passing directly to sea and the rest thoroughly mixed with the comparatively clean inflowing flood current, it has been assumed that the removal of the suspended solids by tank treatment or, if the volume is less than 25 per cent. of the entire 300 million gallons per day, by fine screening, will fulfill every requirement.

Having come to the above rather definite and fundamental conclusions

four general schemes of interception and disposal have been worked out and their cost estimated. These will be described later.

Principles of Design.

The design of main drainage works, depends primarily on the volume of sewage to be handled and that in turn depends on the population served and the amount of storm water admitted. This last is the first thing to consider.

Separate System. Of the sewered areas draining to Jamaica Bay the following are served, or planned to be served, by the separate system—*i.e.*, excluding storm water from the sewers:

Collecting to Caisson No. 4	1.95 sq. mi.
Collecting to Paerdegat Basin	1.17 " "
Collecting to 26th Ward Plant	0.54 " "
Collecting to Jamaica Plant	2.97 " "
Collecting to Far Rockaway Plant	2.00 " "
Total	8.63 " "

As a general proposition, where sewage is to be pumped and treated this can be done more economically and effectively by avoiding the great fluctuations that occur in the storm flow of combined sewers. For this reason the entire City of Baltimore has recently been sewered on a strictly separate system,* as first advised in 1881 by Charles H. Latrobe and, so far as is known, with its advisability never having been questioned. New Orleans is another large city that has recently completed its sewerage on the separate system. In most of our important towns sewers on the combined plan were built before the separation of the storm flow had been suggested.

In 1908 Mr. Rudolph Hering in a report to the Borough President of Manhattan recommended the entire reconstruction of the sewers of that borough on the separate system.

Mr. C. D. Hill, Superintendent, Bureau of Sewers, after a year's investigation of the reconstruction of sewers necessary in the "Loop District" of Chicago in order to conform to the plans for subways recommended five or six years ago by Mr. Bion J. Arnold, gave as his opinion that "it is necessary to completely separate the storm water from the sanitary sewage. Storm drains should flow by gravity to the river, have no siphons and be of ample capacity. * * * Sedimentation basins to intercept the sludge near the river are recommended. * * * A separation of the rainwater ducts and the sanitary sewers of buildings should be effected. Where there are two lines of high-level subway tracks, the sewers and storm-water drains should be placed on each side and cross only where the sewer is depressed. In case there are four subway tracks in the street, then the sewers should be removed to adjacent streets or alleys. Iron or steel pipes suspended on the

*Memphis was the first American city to adopt this system through the recommendation of Geo. E. Waring, Jr., in 1880.

sides of the subway are recommended for the smaller sanitary sewers and reinforced concrete for the larger sizes. Storm-water drains may be built in the subway roof or suspended on the sides above the sanitary sewers."

In Worcester, Mass., the separate system has been superseding the combined system so that in 1915 there were 106 miles on the separate system as against 69 miles on the combined system in addition to 59 miles for surface water only. The same policy is being carried out by the neighboring city of Fitchburg and in all extensions to the Rochester and Milwaukee sewerage systems, while in our smaller towns the separate system may be said to prevail.

Nevertheless, where the combined system has been once established in a large city there is no known instance where it has been entirely abandoned, for conversion to the separate system would entail great difficulty and expense.

Some five years ago the City of Pittsburg, facing the possible necessity of treating its sewage on an island in the Ohio river a few miles below, had a careful estimate of the cost of reconstruction on the separate system made by Mr. N. S. Sprague, Sup't (now Chief Engineer), Bureau of Construction, Department of Public Works. The existing sewers were to be retained for the removal of storm water.

Estimates were based on detailed studies of four typical districts comprising 5,000 acres and 174,833 inhabitants. The data and estimates were as follows:

Data.

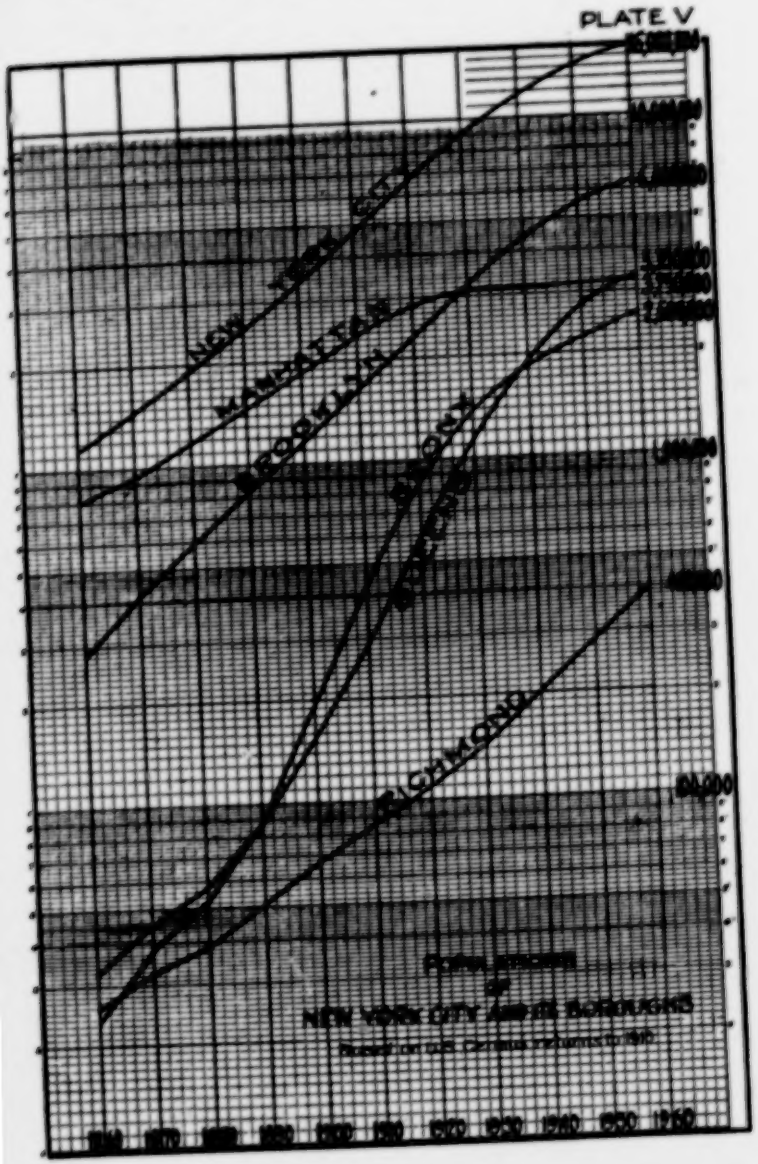
Total net sanitary area	22,456 acres
Population U. S. Census 1910	533,905
Population per acre—average density	24
Estimated number of buildings	88,475
Estimated number of buildings per acre	3.94
Average number of persons per connection	6.1
Total length of streets	4,695,975 feet

ESTIMATED COST OF INSTALLING A SEPARATE SYSTEM OF SEWERS IN PITTSBURG.

	Total	Per acre	Per Capita	Per lin. ft.	Per Building
Sewers Proper	$4,393,407	$195.65	$8.23	$0.94	$49.66
House Connections	1,340,100	59.67	2.51	.28*	15.15
Changing House Plumbing	8,078,220	359.74	15.13	1.72	91.30
	$13,811,727	$615.06	$25.87	$2.94	$156.11
Add 15% for Engineering, Inspection, Contingencies, etc.	2,071,759	92.26	3.88	.44	23.41
Total Estimated Costs	$15,883,486	$707.32	$29.75	$3.38	$179.52

In general it may be said that most cities in which the sewerage is well

PLATE V


NEW YORK CITY
MANHATTAN
BROOKLYN
BRONX
QUEENS
RICHMOND
POPULATION
OF
NEW YORK CITY AND ITS BOROUGHS
Based on U.S. Census enumerations

established on the combined system are not likely to change to the separate system except for some special and perhaps local reason.*

On account of the necessity for pumping and treatment it is believed that the separate system should be retained in those areas where it is established, and adopted for low lying areas collecting to local pumping stations and for such areas as the eastern part of Queens, the character of which is rural or semi-rural. This will permit the sewers to be placed as deep as necessary to afford thorough drainage and, by deferring the construction of most of the storm water drains, greatly reduce the first cost of the work.

Population. Based upon the 1915 populations as determined by the State Census and the results of earlier Federal censuses, and having in view the trend of growth as well as it could be foreseen for so many years, a forecast curve was projected up to the year 1960, bringing the total population of New York City to a total of sixteen million inhabitants at that date (Plate V). The distribution in each borough was then forecast with the following result:

TABLE III.

	Area in Acres		Population**		Density per net Acre	
	Gross	Exclusive of Parks	1915	1960	1915	1960
Manhattan	14,038	12,599	2,137,747	3,250,000	170	258
Brooklyn	45,327	44,116	1,798,513	6,400,000	40.7	145
The Bronx	26,523	22,566	613,600	2,600,000	27.4	127
Queens	69,100	68,024	396,727	3,350,000	5.8	49
Richmond	36,600	36,522	98,638	400,000	2.7	11
New York City	191,588	183,827	5,047,221	16,000,000	27.5	87

The forecast for 1960 is believed to be a proper one, so far as can be seen at the present time, upon which to design important public works. It is intended to err, if at all, on the side of liberality and yet it is to be pointed out that heretofore forecasts of population for large metropolitan areas have almost invariably fallen below the actual result.

Upon this basis the 1960 populations have been distributed over the Brooklyn and Queens areas as seemed most reasonable, having in view improved transit facilities, etc., giving 1,216,000 in Brooklyn and 1,313,000 in Queens draining to Jamaica Bay.

Although any forecast more than 25 or 30 years ahead is liable to more or less error, it is not believed that works of the permanence and magnitude of those under consideration should be designed for less than about 40 years in advance. As a general proposition the smaller the place and the larger

*An example is in some 29 acres near Canal Street, Manhattan, in which it has been decided to put in the separate system to provide deeper and better cellar drainage. The sewage will then be pumped while the storm water will flow at a higher level to the water front as at present.

**Exclusive of inmates of institutions on Blackwell's, Ward's, Hart's, Randall's, Governor's and Riker's Islands.

the percentage of unoccupied territory waiting to be developed the greater is the risk in expending large sums far in advance of their actual needs and the greater the burden on the population to meet the original costs. In other words, Brooklyn would be justified in basing its works on the population of a more remote period than Queens, with a present population of but one-third that of Brooklyn. For this reason the plans have been based upon 1960 populations on the Brooklyn areas and 1950 populations on the Queens areas with a material saving on first cost and possibly on the ultimate cost of construction, to say nothing of interest charges.

For general purposes the area draining to Jamaica Bay may be considered in three main divisions. These areas with the populations in 1915 and as estimated in the future are as follows:

TABLE IV.

Population Tributary to Jamaica Bay.

Location.	Acres to Bulkhead Line	Population in the Year 1915	1930	1960
North of Jamaica Bay, Brooklyn	17,933	311,000	.....	1,216,000
Queens	25,900	103,000	934,000	.....
	43,833	414,000		
South of Jamaica Bay, Queens (Rockaway)	3,510	22,000	120,000	.....
Total	47,343	436,000	1,054,000	1,216,000

The total population provided for in the estimates is the sum of these totals for Brooklyn and Queens, or 2,270,000.

TABLE V.

Average Density of Population per Gross Acre of Territory.

	1915	1930	1960
North of Jamaica Bay, Brooklyn	17.3	..	67.7
Queens	4.0	36.0	..
South of Jamaica Bay, Queens (Rockaway)	6.3	34.2	..
Total area	9.2	47.9*	

Volume of Sewage. The mean dry weather flow of sewage is assumed, for the general purpose of this report, to be equivalent to the water consumption plus a certain amount of ground water infiltration. There will undoubtedly be also trade wastes that will add materially to the local flow

Note—In addition to the above there are about 18,000 acres in Nassau Co. and over 200 in Seaside Park, which drain to Jamaica Bay.

*Corresponding to a population of 2,276,000.

from limited areas but this item is so uncertain and so unlikely to affect materially the flow from large areas that it has been ignored in the estimates.

The water supply in 1915 amounted to 79 gallons per capita in Brooklyn and 100 gallons per capita in Queens. The probable daily supply for the year 1925 has been estimated by the Department of Water Supply, Gas and Electricity for:

Brooklyn	Under present conditions of metering	98 gal. per cap.
	With general use of meters	80 " " "
Queens	Under present conditions of metering	108 " " "
	With general use of meters	95 " " "

It is believed that the practice of metering supplies to consumers will be extended with the lapse of time in spite of the temporary increase in the available per capita supply by the introduction of Catskill water and that there will be a general tendency, as the prospect of the necessity for a further increase in the supply looms up, to conserve the supply already developed. For the purpose of these estimates it has been assumed that for Brooklyn provision should be made for an amount of sewage equal to 90 gallons per capita daily, and for Queens an amount equal to 100 gallons per capita daily, to which should be added something for the infiltration of ground water.

The sewers delivering to the works will be in part old and in part new, in part well built and probably some of the older ones poorly built, some located in dry soil and others in wet and porous material.

Without attempting to classify the conditions favoring infiltration in different areas it has been assumed that this will amount to 10,000 gallons daily per mile of sewer. It is further assumed that after being fully developed there will be 25 miles of sewer per sq. mi. of territory so that the infiltration may be taken as one million gallons daily per sq. mi. or .0024 cu. ft. per second per acre of territory drained.

With these assumptions the following volumes of sewage will have to be taken care of in about 40 years:

TABLE VI.

Volumes of Sewage to Be Taken Care Of.

		Million Gallons per Day
North of Jamaica Bay:	Brooklyn	137.5
	Queens	134.5
		272.0
South of Jamaica Bay:	Queens (Rockaway)	20.0
Total		292.0

To these 20 million gallons per day from Far Rockaway and the

Rockaway peninsula there should be allowed in the capacity of the work for an added volume during the summer season due to transients in the beach hotels and excursionists who will come here in increasing numbers.

This, as explained hereafter, is estimated to add 4 mgd to the above 20 mgd during the summer months reaching a maximum rate during the day of 8 million gallons, making a total for the Rockaways of 28 and for the entire area tributary to the bay nearly 300 million gallons per day.

The daily fluctuation of the dry weather flow will be less in the intercepting sewers than in the mains and laterals in which there is less opportunity for equalization. In the design of interceptors and treatment plants it is assumed that the maximum rate of dry weather flow will be equal to the infiltration plus 1½ the mean water consumption, but as a safety factor to provide for unforeseen contingencies and also to care for the first flush of storm water brought down by combined sewers the capacity of interceptors and treatment plants is assumed to be equal to 1½ times the infiltration of ground water plus twice the mean dry weather flow of domestic sewage. Under ordinary conditions, then, a volume of storm water slightly less than the mean dry weather flow of sewage may enter the interceptor ultimately, while in the early years a much larger amount may be admitted.

Storm Water. The surface water of natural streams and the storm run-off will eventually be carried in combined sewers or in special drains provided for the purpose. Combined sewers should be provided with overflow or relief conduits at points of interception to carry the excess over twice the ultimate mean dry weather flow to the most convenient point of outlet while storm drains will be carried directly to such points.

After the interceptor has received its full complement of sewage and storm water the excess combined sewage will pass untreated to the bay. This will occur at such long intervals and in so dilute a form that no serious objection can be made.

Advantage should be taken of the proposed basins for docking purposes to shorten the length of these storm drains and to furnish a certain renewal of the waters in the basins. But before the discharge of large volumes either to the basins or the bay they should have the grosser solids removed by grit chambers and coarse screens with openings of from 2 to 3 inches between bars.

In the design of these drains it is recommended that the percentage of run-off provided for vary from not less than 75 for well developed areas to 50 for partially developed areas and about 20 for parks and cemeteries.

Some of them will eventually be of large size—notably one draining the valley running from Creedmoor along Springfield Boulevard to the bay—a distance of about 8 miles. Fortunately the greater part of this expense can be deferred for an indefinite time, for the land drained is now almost entirely rural in character; but its ultimate necessity should be kept in view.

While the works of main drainage herein described provide essentially for the dry weather flow, which consists principally of domestic sewage, the tributary sewers may or may not carry storm water as well. In those areas in which the separate system is recommended it may be well to suggest that to serve as a temporary relief from flooding in ordinary storms while avoiding the excessive cost of constructing the large storm water drains that will eventually be required, the sewers proper may be made somewhat excessive in size, sufficient perhaps for six or eight times the dry weather flow, and so serve in a limited capacity as combined sewers until the territory is sufficiently developed to demand the construction of more adequate storm water drains. If this policy is carried out it should be made clear to property owners that any connections that may be permitted of rain water leaders to the sewers must be considered as of a temporary character only, and that when this arrangement becomes undesirable connection shall be made with storm water drains which should by that time be provided.

Hydraulic Grade. The mean tidal range in Jamaica Bay, according to the U. S. Coast and Geodetic Survey, is at:

Barren Island.....	4.3 ft.	Norton Point....	4.0 ft.
Holland Landing....	4.3 ft.	Canarsie	4.5 ft.

The level of mean high water is therefore about 2.1 above mean tide datum. But to prevent flooding of the treatment plant, the hydraulic grade at the outlet should be taken at the level of extreme high water. Spring tides coincident with easterly winds raise the surface from 4 to 4½ feet above mean tide level several times in a year as indicated by the following gage records of the Dock Department at Canarsie and at Seaside.

TABLE VII.

Number of Times the Tide has risen to the following Elevation above M. T. L.

	4.0 to 4.5	4.5 to 5.0	5.0 to 5.5	5.5 to 6.0	6.0 to 6.5	Above 6.5
Canarsie:						
1899.....	9	3	2	..	..	..
1900.....	12	3	1	..	..	..
1901.....	14	3	..	1	..	..
1902.....	17	2	1	4*	1* (7.1 on Jan. 20) (7.5 on Jan. 21) (8.5 on Jan. 21)	
1903.....	10	8	3	..	..	..
1904.....	6	3	1	..	..	..
1905.....	3	..	..	..	..	..
1906.....	9	2	..	..	..	..
Seaside:						
1907.....	28	5	..	..	..	..
1908.....	18	12	..	..	..	..
1909.....	41	13	4	..	..	..
1910.....	12	5	2	..	..	..

*These all occurred between January 18th and January 21st

In this record of 12 years there were but four times, all within three days, when the surface rose more than 6 feet above mean sea level. It would be obviously unwise to incur any considerable expense in order to provide for such a rare contingency and in the plans the hydraulic grade at the outlet has been assumed at +6.0 with mean sea level at Sandy Hook as datum.

Starting at this point the hydraulic grades have been computed for the several interceptors, using the Kutter formula with friction coefficients of .013 for cast iron or vitrified clay pipe and .015 for concrete or brick work.

Velocities in interceptors have been assumed at from 2.25 to 3.3 ft. per second when running full or half full, the higher rates applying to the larger sizes approaching the point of disposal. In this way the head is conserved where gradients are necessarily high, while there is a material economy in the smaller diameters and but slight loss of head in adopting the higher velocities where very large sizes are necessary. There is the further advantage that an increasing velocity toward the outlet will tend to prevent the accumulation of deposits.

Treatment. It is assumed that all sewage will pass through grit chambers before pumping, primarily to prevent undue wear of the pump impellers, but also to prevent the clogging of sludge pipes from sedimentation tanks.

Sedimentation plants will consist of Imhoff tanks from which the digested sludge will be drawn to sludge beds for drying and then used for filling in waste land. If it should ever be found desirable through lack of space to discontinue this practise, the sludge can be drawn from the tanks to sludge steamers and dumped at sea, as is customary in the large coast cities of Great Britain.

For some years the standard methods of oxidizing treatment have been intermittent sand filtration, contact beds and sprinkling filters, the preference for large installations having been for the latter. It has been claimed, however, that such plants are liable to produce odors that are objectionable to the neighborhood.

In view of the necessity of adopting some treatment to furnish a stable effluent if discharged into Broad Channel or the upper end of Big Channel it has seemed desirable to secure more definite knowledge on this point than is generally found in print and inquiries were made concerning some 40 municipally-operated plants. Answers were received from 14 of these, including the more important installations in the United States, a summary of which is given in Table VIII to which may be added the following comments:

> *Batavia, N. Y.* "No flies cause any trouble. . . . Should the sprinkling filters be shut down for a period of two days a very small fly will show itself. They become

very numerous only in warm weather, but soon disappear after the filter is again in operation."

"My residence is located 129 ft. west of Imhoff tanks and the sludge drying beds are located 36 ft. north east of house and I have never wished myself away from here since the plant is in operation."

HENRY F. LAMBERT, *Sup't.*

Reading, Pa. "There have been no complaints due to the operation of the filters, tho the cleaning of the settling tank and settling basins has caused odors that were observed at a distance of a quarter of a mile, due to the presence of worms in the sediment, on account of which complaints have been made. This is noticed more especially at the first spring cleaning."

E. B. ULRICH, *City Engineer.*

Atlanta, Ga. "There are no residents near any of the sewage plants except the caretakers' houses. These houses are within 300 ft. of the plant, and the occupants have never been inconvenienced from odors from the plants.

"There has never been any complaint of any nature whatsoever that I am aware of registered against the plants either from odors, flies or mosquitoes."

CHARLES C. HOMMON, *Chemist and Bacteriologist.*

Fitchburg, Mass. "I have visited the location many times of the nearest residences for the purpose of ascertaining if any odors were noticeable but have never been able to detect any trace. . . . The nearest building occupied for any purpose are residences situated about 1,000 feet from the filters.

"No complaints of any nature have been made by any occupants of residences either near the works or at a distance."

DAVID A. HARTWELL,
Chief Engineer, Sewage Disposal Commission.

Columbus, O. "Any odor emanating from a sewage plant is regarded as disagreeable and objectionable.

"Residents have complained of odor. Cause—stale condition of sewage unavoidable without extra treatment."

C. B. HOOVER, *Chemist in Charge.*

Baltimore, Md. "Mean daily flow at Back River—at present about 45 million gallons. . . . The sewage is stale when it reaches the plant. Dissolved oxygen is never found in the raw sewage . . . the sewage delivered to the nozzles is septic. . . . Many times I have walked along the side of the filters and noticed no odor.

"Any odor from a disposal plant is likely to be called unpleasant and disagreeable by a resident. To me the odors from a sprinkling filter are seldom disagreeable; they seem to resemble the smell from a pile of oyster shells, or from a laundry.

"It is quite difficult, 400 yards away from the plant, to detect the origin of odors. As a general thing, I feel that sprinkling filters are blameless for a lot of the smells arising from a sewage disposal plant.

"Nothing has been done to rid the plant of the fly pest. The little familiar white fly is very evident at times at Back River. He multiplies by millions in the filter stove."

GUSTAV J. REQUARDT.*

*F. E. Daniels*** writes: There are usually other conditions, such as bad sludge beds or improper or badly kept scum or grit chambers, which greatly interfere with determinations concerning odors from the sprinkling filters themselves. If the sewage can be delivered in a fresh condition, I do not feel that there is much danger from odors."

Harrison P. Eddy. "In my judgment, while I do not wish to belittle the danger of odors, there is a decided tendency to exaggerate the danger, when cases are brought into court to collect damages, or to enjoin sewage treatment plants.

"At a hearing in the court at Schenectady last fall, I was asked the following questions, to which I have appended my replies:—

Q. "With a plant of this same character, and working efficiently, and in a warm period, when the atmosphere is at low pressure, and a slight movement of air, at what distance, if you can say, will odors from the plant be smelled?

A. This plant?

*Formerly Acting Division Engineer in charge of the plant.
**Asst. Eng. State Dept. of Health of Pennsylvania.

Table VIII.

ODORS DUE TO SPRINKLING FILTERS.

No.	Town	Volume of Sewage Gals. per Day	Condition at Tanks	Delivery Nozzles	Distances that Odors Are Noticeable: Unfavorable Conditions	Noticeable: Once a Month in Summer	Objectionable: Unfavorable Conditions	Objectionable: Once a Month in Summer
1	Atlanta, Ga.	13,000,000	2 plants Fresh 1 plant Stale	Fresh Stale	400 ft. 700-800 ft.	....	....	....
2	Baltimore, Md.	45,000,000	Stale	Septic	⅓ to ½ mile	....	⅓ to ½ mile	....
3	Batavia, N. Y.	2,000,000	Slightly Septic	Slightly Septic	300 ft.	....	None	None
4	Bloomington, Ind.	600,000	Fresh	Septic	1,000 ft.	....	800 ft.	....
5	Chambersburg, Pa.	700,000	Fresh	Fresh	½ mile	½ mile	1,000 ft.	1,000 ft.
6	Columbus, Ohio.	21,000,000	Septic	Septic	1 mile	¼ mile	1 mile	¼ mile
7	Fitchburg, Mass.	2,123,000	Fresh	None over 8 hrs. old	300-400 ft.	....	None	None
8	Gloversville, N. Y.	2,800,000	Fresh	Fresh	500 ft.	500 ft.	None	None
9	Indiana, Pa.	657,000	Fresh	Septic	200 ft.	400 ft.	....	400 ft.
10	Lebanon, Pa.	800,000	Fresh	Septic	Practically no odor		300 ft.	None
11	Philadelphia, Pa.	1,250,000	Fresh	Fresh	500 ft.	Ordinarily less than 50 ft.	500 ft.	Ordinarily less than 50 ft.
12	Reading, Pa.	6,000,000	Fresh	Settled 7 hrs.	300 ft.	....	300 ft.	....
13	Schenectady, N. Y.	10,000,000	Fairly Fresh	Nearly Stale	700 ft.	....	700 ft.	300 ft.
14	Washington, Pa.	1,400,000	Septic	Septic	1,500 ft.	400 ft.	1,200 ft.	300 ft.

No.	Distance to Nearest Residence	Complaints Due to Odors, Flies, Etc.	Eff. on Property Values Due to Construction and Operation of Plant	
1.	300 ft.	None	Property values about plants have increased	C. C. Hommon, Chem. and Bact't.
2.	1,300 ft.	Several compaints due to odors and flies.	None	G. J. Requardt, Formerly Div. Eng. in Ch. Sew. Disp.
3.	381 ft.	None	None	H. F. Lambert, Supt. Sew. Disp.
4.	1,500 ft.	Complaints from flushing about 3 times a year. None from plant.	....	C. E. Danner, City Eng'r.
5.	600 ft.	None	None	J. H. Atherton, Boro. Eng'r.
6.	1,300 ft.	Complaints due to stale condition of sewage.	An alleged decrease. Unable to verify	C. B. Hoover, Supt. Sew. Disp.
7.	1,000 ft.	None	None	D. A. Hartwell, Ch. Eng. Sew. Disp.
8.	900 ft.	Complaints due to sludge beds—none to filters.	4 properties 200'-600' from sludge beds deprec. 25-33⅓%	H. J. Hanmer, City Eng'r.
9.	1,300 ft.	One Complaint due to sludge removal.	None	F. E. Daniels, Ass't Eng. St. Bd. Hlth.
10.	600 ft.	None	None	P. A. Volcker, City Eng'r.
11.	2,000 ft.	None	None	W. L. Stevenson, Ass't Eng. Sew. Disp.
12.	1,300 ft.	Complaints due to cleaning tanks—not to filters	None	E. B. Ulrich, City Eng'r.
13.	1,100 ft.	Complaint due to undigested sludge in early op'n of plant.	None	W. E. Weller, City Eng'r.
14.	1,000 ft.	Complaints from disch. of undigested sludge. None for 2 years.	Apparently none	D. C. Morrow, Boro. Eng'r.

Q. An efficient plant of this same character.
A. Acting on this sewage?
Q. Acting on sewage just like this.
A. I should say not over 300 feet.
Q. Even though it was a time when the air was very light and little circulation of air?
A. "Yes, sir."

"I should state, however, that I think there may be evidence that odors have been noticed at greater distance than that I have mentioned in my testimony. These occasions, however, have been rare and probably not more than once a month on the average during the summer."

So far as can be learned from these answers as well as from personal visits to a large number of plants it is my opinion that if the sewage is reasonably fresh and the plant properly designed and operated, odors will rarely be noticed at a distance greater than 600 or 800 feet. But two of the cities heard from,—Baltimore and Columbus,—have had complaints traceable to sprinklers, and in both cases the sewage is delivered in a septic condition.

The question arises: How old must sewage be to reach this condition? Obviously this depends on the constituents of the sewage, the temperature, its access to the open air and its possible contact with decomposing deposits.

There is so little accurate information to be had as to the velocity of flow in sewerage systems that it is difficult to assign any definite period of collection that is necessary to bring the sewage to a septic condition. It would obviously be unfair to take this period as that required to deliver the sewage from the most extreme point of the system, as the tendency to septicize this presumably small portion of the whole, would be partly neutralized by the larger subsequent volumes of inflow containing a residuum of oxygen. Probably a point somewhere between the centre of population and this extreme point would be more reasonably assumed as the point from which the oxygen is gradually depleted until reaching the treatment plant.

Mr. F. D. Smith, Chief Engineer of Sewage Works, Metropolitan Water and Sewage Board of Massachusetts, writes:

"The sewage of the Metropolitan sewers is in general, in a septic condition when discharged through the outfalls owing to the length of the mains. Some of these mains together with the lateral sewers have a length exceeding twenty-five miles.

"I am not able to state definitely the length of time before the sewage could be termed stale or septic. The chemist of the State Department of Health of this State who makes examination of the condition of sewage in our sewers, informs me that after twenty to twenty-four hours, depending upon the season of the year, they regard the sewage as septic."

By reference to Table VIII it is noted that the sewages of Batavia and Schenectady reach the plant at about the time when becoming septic.

At Batavia decomposition seems to be promoted by deposits in the sewers as "if the sewers are flushed once a year during the summer months the sewage arrives at the plant in a fresh state." This would be expected as the extreme distance traveled is but about 2½ miles.

At Schenectady the extreme flow is about 6 miles and that from the centre of population about 4½ miles as measured along the sewer.* A careful computation by Edward H. Prentice† indicates the extreme distance and time of travel by two routes to be:

Route 1. From State Street 5.9 miles, 4 hrs. 36 mins.
Route 2. From 15th Street 6.45 miles, 5 hrs. 56 mins.

According to Mr. W. E. Weller the sewage is fairly fresh on arrival but is approaching staleness on reaching the nozzles after settling.

From Table VIII we also see that the sewage arrives at one of the Atlanta plants and at the Baltimore, Md., Columbus, O., and Washington, Pa., plants in a stale or septic state.

The extreme distance of travel at Atlanta is about 5 miles, and that from the centre of population 4½ miles. The maximum time of travel is about 4½ hours, due in part to the flow for about ¾ mi. through an old creek bed which will be replaced by a sewer later when the sewage is expected to arrive in a fresh condition.

At Baltimore the sewage from the centre of the city travels about 8 miles and is some 5 hours old when received, although some is probably derived from a distance exceeding 10 miles.

At Columbus the centre of population is stated by Mr. C. B. Hoover to be four miles but the most extreme point ten miles from the plant.

At Cleveland a travel of 5 miles renders the sewage "distinctly stale."‡

From the above it would appear that *sewage brought from a distance of over 6 or 8 miles from the centre of population under ordinary conditions of flow and in warm weather is likely to arrive in a stale condition.* This is confirmed by the condition of the sewage reaching the sewage testing station at Cleveland, where it arrives in this condition when 6 or 8 hours old, while, indicating this to be about the limit, the sewage from Fitchburg reaches the plant when most of it is not over three but some of it nearly eight hours old in a fresh condition.

This conclusion, being based upon so few examples, must of course be considered as tentative and liable to modification and in any case the limiting time depends, as already pointed out, on such matters as temperature and contact with the air.§

*W. E. Weller, formerly Acting City Engineer. Now City Engineer, Binghamton, N. Y.
†City Engineer, Amsterdam, N. Y.
‡Pratt and Gascoigne. Eng. News, Dec. 7, 1916, p. 1062.
§In the Emscher District in Germany sewage effluents are carried many miles in open channels with an average velocity of 2.3 feet per second and it is claimed that instead of becoming septic the sewage improves through contact with the air and the effect of the sunlight.

The foregoing discussion indicates in a general way that a nuisance may arise from a sprinkling filter plant; that experience in other cities goes to show that such nuisances are more apt to be traced to other features of the plant, such as sludge handling, than to the operation of the filters themselves; and that odors are liable to be produced during warm weather by sprinkling filters handling a stale or septic sewage that may affect property values located a quarter of a mile or more from the plant.

It is probable, too, that sewage delivered from ordinary septic tanks to sprinkling filters is more liable to cause odors than when delivered from Imhoff tanks, not only on account of the longer retention customary with the former type, but on account of the withdrawal of oxygen due to contact with the decomposing sludge and to absorption of the malodorous gases evolved during this decomposition.

Where large volumes of sewage are to be treated, therefore, sprinkling filters should hand fresh sewage only, or else be placed far from habitable property.

In the selection of a method of oxidizing treatment for a period of 40 years or so hence the more sluggish flow, and consequently nearer approach to a septic condition of the sewage on reaching the plant that will obtain during the early years of operation, should not be overlooked. With a velocity of, say, 1.5 instead of 3 ft. per second the age of the sewage would be doubled and in addition there would be the greater liability of deposits, resulting in an additional draft on the oxygen remaining in the liquid with a further reduction of the time required to bring about anaerobic decomposition. Another consideration which has not been touched on is the area required. If, for instance, it should turn out that the activated sludge process were otherwise advantageous, it would have the additional merit of requiring much less area—probably from a quarter to a fifth of that necessary for sprinkling filters. In some locations this would be a consideration of much importance.

Activated Sludge Process. Recent developments in the activated sludge process, now in operation at Milwaukee, Wis.; Houston and San Marcos, Texas; Escanaba, Mich.; Edmonton, Alberta and Worcester, England, give rise to the hope that a practicable method has been found for the oxidation of sewage which, if properly carried out, will be free from the danger of nuisance and at a cost that is not prohibitive. This result will depend largely on the cost of electric or other power and the possible revenue to be derived from the sale of the dried sludge. In many situations it is believed the cost would exceed that of other forms of treatment to such an extent as definitely to preclude its adoption. The experience with this process at the above places together with the results of experiments being carried on at the 26th Ward plant in Brooklyn, at Milwaukee, Wis., the Chicago Stock Yard and Champaign, Ill.; Lawrence, Mass.; Cleveland, O.; Ann Arbor, Mich., and Balti-

more, Md., as well as in England should enable us to draw pretty definite conclusions as to the merits of this process by the end of another year.

In the following projects the particular kind of oxidation plant is left open. Estimates are based upon the known cost of sprinkling filters, but if some equally good process, eliminating even the apprehension of odors, can be developed at no greater cost, this would obviously be the one to adopt.

Intermittent Discharge. As the sewage discharged into the ebb current at Rockaway Inlet passes directly to the ocean, the remainder, discharged into the flood current, is practically the only source that contributes to the pollution of the bay. The question naturally arises why the effluent should not be stored and discharged during the ebb only, much as is done at the Moon Island outlet at Boston.

There are several reasons why this is undesirable. In the first place, the storage of sewage already several hours old, for six or more additional hours will bring about septic conditions resulting in objectionable odors about the tanks and in the neighborhood of the effluent after discharge. The concentrated discharge of 12 hours' sewage within a period of less than half that time will intensify the pollution throughout the sewage field to a very great degree. Finally, the unfavorable effect of this intensification is further increased by the greater and more immediate demand made on the available supply of dissolved oxygen in the waters of the Inlet by the introduction of a septic effluent than would obtain with the addition of an equal volume of fresh sewage so that, for all practical purposes, the result would be equivalent to the discharge of a much larger volume of sewage than proposed. The cumulative deleterious effect of an intermittent discharge after storage is very evident to one crossing the sewage field below the Moon Island outlet, although it is but fair to say that these conditions are both temporary and local and in a locality where there is little navigation. Yet another objection lies in the fact that the discharge of the sewage in from one-half to one-third of the time would necessitate the construction of extensive and costly storage tanks, with effluent channels and outlet pipes of from two to three times the capacity otherwise required.

The suggestion may, therefore, be dismissed without further comment.

Description of Proposed Projects.

In the four projects described below the main drainage of the district comprising the Rockaways is treated independently of that of the district lying north of Jamaica Bay and, except as to the concentration of effluents in the bay, the two systems bear no relation to each other.

The points of concentration in the northern sub-districts are pretty well fixed by existing conditions. The sub-districts assumed, with their areas, populations and mean dry weather flow, are as follows:—

TABLE IX.

Areas, Populations and Sewage Flow of Sub-Districts.

a. North Jamaica Bay District.

Sub-District No.	Designation	Area Acres	Population 1915	Population Provided for	Mean Dry Weather Flow Provided for. Mgd. Domestic	Ground Water	Total
I	Shellbank	1,250	2,000	69,000	6.2	2.0	8.2
II	Flatbush	4,683	32,000	155,000	14.0	7.4	21.4
III	Barren Id.	2,462	1,000	8,000	0.7	3.9	4.6
IV	Paerdegat	3,828	25,000	260,000	23.4	6.3	29.7
V	Hendrix	5,570	250,000	720,000	68.4	8.8	73.6
VI	Genesee	1,986	14,000	122,000	12.2	3.0	15.2
VII	Woodhaven	1,062	2,000	69,000	6.9	1.7	8.6
VIII	Panama	3,360	46,000	247,000	24.7	4.6	29.3
IX	Jamaica Plant.	2,735	4,000	74,000	7.4	4.3	11.7
X	Jamaica	3,721	29,000	167,000	16.7	5.8	22.5
XI	St. Albans	2,976	5,000	79,000	7.9	4.6	12.5
XII	Springfield	10,200	4,000	180,000	18.0	16.0	34.0
	Total	43,833	414,000	2,150,000	202.9	68.4	271.3

b. South Jamaica Bay District.

Sub-District No.	Designation	Area Acres	Population Provided for 1915	Population Provided for exc. Trans.	Mean Dry Weather Flow Provided for. Mgd. Domestic Res't	Domestic Trans.	Ground Water	Total
I	Far Rockaway	1,400	9,000	42,000	4.2	2.0	3.2	9.4
II	Conch	180	....	3,000	0.3	..	0.4	0.7
III	Arverne	870	5,000	24,000	2.4	2.3	2.0	6.7
IV	Steeple Chase	400	6,000	25,000	2.5	2.0	0.9	5.4
V	Neponsit	660	2,000	26,000	2.6	1.7	1.5	5.8
	Total	3,510	22,000	120,000	12.0	8.0	8.0	28.0

It has been thought best to provide for a large transient population at the Rockaways on certain days in summer. The maximum number of visitors has been assumed as 400,000 and it has also been assumed that this population will produce, by wastes from restaurants, hotels, laundries, lavatories and water closets an average of 10 gallons of sewage per day each, or in all 4 million gallons. It is further assumed that this will be discharged within 12 instead of 24 hours so that it will be equivalent to 8 million gallons per day in the capacity to be provided for the sewers. And while during the winter months there will be but 20 million gallons to be treated, the treatment plant should have a capacity to handle 24 million gallons daily.

Four projects have been worked out for the entire area. For the North District the main consideration is the volume of sewage, if any, which may be treated advantageously at Jo Cos Marsh and near the present Hendrix

Street plant. For the South District the choice lies between concentration near Jo Cos Marsh, concentration near Rockaway Inlet, or local treatment at a number of selected points. They are as follows:—

TABLE X.

List of Projects.

Project	District	Concentration Point	Mgd.	Treatment	Discharge to
A	North	Barren Island	272	Sedimentation	Rockaway Inlet
	South	Silver Hole Marsh	24	Oxidation	Broad Channel
B	North	Barren Island	209	Sedimentation	Rockaway Inlet
		Joe Cos Marsh	63	Oxidation	Broad Channel
	South	Little Egg Marsh	24	Sedimentation	The Raunt
C	North	Barren Island	153	Sedimentation	Rockaway Inlet
		Jo Cos Marsh	119	Oxidation	Broad Channel
	South	Neponsit	24	Fine Screening	Beach Channel
D	North	Barren Island	64	Fine Screening	Rockaway Inlet
		Hendrix Street	174	Oxidation	Big Channel
		Jo Cos Marsh	34	Oxidation	Broad Channel
	South	Brant Point	14	Sedimentation	Grass Hassock Channel
		Seaside	4	Sedimentation	Beach Channel
		Neponsit	6	Sedimentation	Beach Channel

Unit Prices. The estimates are based on the following unit prices:

Excavation and refill, including sheeting, bracing, pumping, etc.	$1.50 to $3.00 per cu. yd.
Concrete	8.00 " " "
Reinforced concrete	12.00 to 16.00 " " "
Cast iron pipe	35.00 per ton
Paving and repaving	$2.00 per square yard
Piling	.40 per linear foot
Lumber in foundations	40.00 per M b m
Grit Chambers	1,000.00 per mgd. capac.
Operation	.50 per mg.
Fine Screening Plants	Uncertain under present conditions.
Operation	1.50 per mg.
Sedimentation Plants	13,000.00 per mgd. capac.
Operation	1.50 per mg.
Oxidation Plants	45,000.00 per mgd. capac.
Operation	4.50 per mg.
Fixed charges—(Int. @ 4½%)—Structures	5% of cost annually
Mechanical Equipment	9% of cost annually

Datum is assumed at mean sea level Sandy Hook in all projects and the hydraulic grade at outlets is assumed at elevation +6.0.

Land. No allowance is made in the estimates for the acquisition of land.

1. Main Drainage of Territory Lying North of Jamaica Bay.

Project A.

By Project A all of the 272 mgd of sewage produced north of Jamaica Bay will be carried by interceptors to Barren Island where it will be treated and the effluent discharged into Rockaway Inlet.

The East Interceptor starts at Rockaway Boulevard and 136th Avenue with a diameter of 8 ft. 0 in., and follows 136th Avenue, North Conduit Avenue, Old South Road, 134th Street, Fairfield Avenue, Flatlands Avenue, Ralph Avenue, and Avenue T to Flatbush Avenue. From 134th Street (Baker Avenue) and Stanley Avenue a box section with a uniform height of 10 ft. is provided in order to secure a greater cover and less cut than by the use of a circular section. At Stanley Avenue the width is 11 ft.; at Panama Street two conduits 8 ft. wide are adopted and these increase in width to 9 ft. at Genesee Street and to 14 ft. 6 in. at Hendrix Street.

The West Interceptor receives the sewage from Caisson No. 4 by a 12-inch force main at Knapp Avenue and Avenue Y beginning with a diameter of 15 in., follows Knapp and Gerritsen Avenues and Avenue T to Flatbush Avenue, where it has a diameter of 33 in.

From Avenue T the combined flow is carried by two 10 ft. x 14 ft. 6 in. box sewers to a pumping station near Mill Basin.

Grit chambers are placed in front of a siphon which consists of four 66 in. pipes, passing under Fresh Creek Basin, and in front of the Mill Basin Pumping Station.

The sewage now delivered to the 26th Ward treatment plant from the Malta Street sewer only will have to be lifted about 5 ft. at Hendrix Street* and it is probable that the sewage received at Paerdegat will have to be lifted about the same amount, depending on the drainage plan finally adopted at this point.

At Mill Basin Pumping Station the elevation of the top inside is —3.41 and the hydraulic grade at times of maximum flow —6.55. From here the sewage is pumped to the treatment plant on Barren Island through 11,000 ft. of force main consisting of 3 conduits 7 ft. in diameter.

The treatment plant consists of Imhoff tanks with the necessary sludge-drying beds, laboratory, etc.

From the tanks an outfall conduit 860 ft. long consisting of two channels about 11ft.x7ft. in size conveys the effluent to a gate chamber from which it flows through nine 48-inch submerged pipes averaging 900 ft. long to outlets in the bottom of Rockaway Inlet, where the depth at low tide is from 25 to 35 feet.

Estimate.

Construction		$14,295,000
Maintenance and Operation	$494,200	
Fixed charges	727,800	
Total annual charges		$1,222,000

*By pumps located in the existing 26th Ward Plant. If pumped at Malta Street the lift would be about 3 feet.

PLATE VI

JAMAICA BAY MAIN DRAINAGE - PROJECT A

SKETCH SHOWING

ELEVATIONS OF MAIN SEWERS AND INTERCEPTORS AT POINTS OF INTERCEPTION

SCALE - 1" = 10'-0"

DATUM - MEAN SEA LEVEL AT SANDY HOOK

Project B.

In Project B the 208.4 mgd derived from, and to the west of, Jamaica is carried to Barren Island where it is settled and discharged into Rockaway Inlet as in Project A.

The remaining 62.8 mgd from the area between Springfield and Creedmoor is carried to Jo Cos Marsh, treated by some process of oxidation and discharged into Broad Channel.

Western Division. The East Interceptor starts at the existing Jamaica Disposal Plant which may be utilized as a pumping station for such of the sewage concentrated to that point as cannot be intercepted by gravity, and, beginning with a diameter of 63 in. continues in Baker Ave., Fairfield Ave., Flatlands Ave., Ralph Ave., and Avenue T to Flatbush Ave. From Fairfield and Woodhaven Avenues a box section with a uniform height inside of 8 ft. 6 in. is provided. From Woodhaven Ave. to Genesee St. the width is 10 ft., from Genesee St. to Hendrix St. 12 ft., from Hendrix St. to Paerdegat and Ralph Ave., there are two conduits 12 ft. wide and from this point to Flatbush Ave., there are two conduits 14 ft. wide.

The West Interceptor receiving sewage from Caisson No. 4 at Avenue Y, runs to Flatbush Ave., with diameters of from 15 to 33 in. and the combined flow is carried from Avenue T to the Mill Basin Pumping Station by two 8 ft. 6 in. x 14 ft. box sewers.

Grit chambers are placed in front of a siphon, which consists of three 60 in. pipes passing under Fresh Creek Basin, and in front of the Mill Basin Pumping Station.

A part of the sewage received at Hendrix St. and at Paerdegat will have to be pumped. At Mill Basin Pumping Station the elevation of the top inside is —5.50 and the hydraulic grade at times of maximum flow —8.20. The force main to Barren Island is 11,000 ft. long and consists of three pipes 6 ft. in diameter.

The treatment plant consists of Imhoff tanks, sludge beds, laboratory, etc.

Two 9.7 ft. by 7 ft. conduits convey the effluent to a gate chamber from which seven 48-in. submerged pipes averaging 900 ft., in length lead to outlets in Rockaway Inlet.

ESTIMATE.

Construction		$11,118,000
Maintenance and Operation	$377,100	
Fixed Charges	564,900	
Total Annual Charges		$942,000

Eastern Division. A 48 in. interceptor, receiving 16.3 mgd at its upper end carries the tributary sewage along the Rockaway Boulevard from 136th

Ave. to Springfield Boulevard where its flow averages 18 mgd. Here it is joined by 44.8 mgd tributary directly to this point or conveyed by a main sewer running along Springfield Boulevard from Creedmoor, and the entire 62.8 mgd pumped through two 48-in. force mains 14,950 ft. to an oxidizing plant on Jo Cos Marsh. The effluent passes by 750 ft. of open conduit and two 48-in. outlet pipes to points in Broad Channel and Hassock Creek where the depth at low tide is about 12 ft.

ESTIMATE.

Construction		$4,301,000
Maintenance and Operation	$230,700	
Fixed Charges	218,000	
Total Annual Charges		$448,700

Project C.

In Project C the 152.6 mgd collected at and west of Genesee Street is carried to Barren Island where it is passed through tanks and discharged into Rockaway Inlet as in Project A.

The remaining 118.6 mgd from Queens is carried to Jo Cos Marsh, treated by oxidation and discharged into Broad Channel as in Project B.

Western Division. The East Interceptor intercepts the proposed Genesee Street sewer and, beginning with a diameter of 4 ft. 9 in., runs on Fairfield Avenue, Flatlands Avenue, Ralph Avenue and Avenue T to Flatbush Avenue. From Hendrix Street and Fairfield Avenue a twin box section is adopted with a uniform height inside of 7 ft. 6 in. From Hendrix Street to Paerdegat each section is 9 ft. wide and from Paerdegat to Flatbush Avenue 11 ft. wide.

The West Interceptor receives the sewage from Caisson No. 4 by a 12 inch force main at Knapp Avenue and Avenue Y, and extends to Flatbush Avenue and Avenue T with diameters increasing from 15 to 33 inches. From this point the combined flow is carried from Avenue T to the Mill Basin Pumping Station by two 7 ft. 6 in. by 12 ft. 6 in. box conduits.

Grit chambers are placed in front of a siphon, consisting of three 60 inch cast iron pipes, under Fresh Creek Basin and in front of Mill Basin Pumping Station.

A part of the sewage collected at Hendrix Street and Paerdegat will have to be pumped. At Mill Basin Pumping Station the elevation of the top inside is —6.67 and the hydraulic grade at times of maximum flow —9.00. The force main to Barren Island consists of three 5 ft. pipes 11,000 ft. long.

The treatment plant consists of Imhoff tanks, sludge beds, laboratory, etc.

Two 8 ft. by 7 ft. conduits convey the effluent to a gate chamber from which five 48 in. submerged pipes averaging 900 ft. in length lead to outlets at the bottom of Rockaway Inlet.

ESTIMATE.

Construction		$7,536,000
Maintenance and Operation	$313,500	
Fixed Charges	385,000	
Total Annual Charges		$698,500

Eastern Division. An interceptor having its upper end at Woodhaven Avenue extends to Panama Street with a diameter of 42 in. and then along Fairfield, Baker and 152nd Avenues and Rockaway Boulevard to Springfield Boulevard with diameters of from 7 ft. 6 in. to 9 ft. 6 in. At this point its mean dry weather flow of 72.1 mgd is increased by 46.5 mgd brought by a main sewer running along Springfield Boulevard from Creedmoor and the entire 118.6 mgd pumped through 4 lines of 48 in. force main 14,950 ft. to an oxidizing plant on Jo Cos Marsh. The effluent then passes by 750 ft. of open conduit and four 48 in. outlet pipes to points in Hassock Creek and Broad Channel where the depth at low tide is about 12 ft.

ESTIMATE

Construction		$9,228,000
Maintenance and Operation	$439,400	
Fixed Charges	467,300	
Total Annual Charges		$906,700

Project D.

By Project D the 63.8 mgd of sewage collected west of Fresh Creek Basin is carried to Barren Island where it is passed through fine screens and discharged into Rockaway Inlet.

Between Fresh Creek and Rockaway Boulevard 173.4 mgd is collected to the present 26th Ward Disposal Plant, which will be converted into a pumping station, and pumped to an oxidizing plant located just north of the present shore line but about 1/3 mi. from the established bulkhead line. The effluent will flow into Big Channel.

The 34 mgd of sewage from the territory east of Rockaway Boulevard will be collected to a pumping station near the intersection of Springfield and Rockaway Boulevards where it will be pumped to an oxidizing plant on Jo Cos Marsh and discharged into Broad Channel.

Western Division. The East Interceptor starts at Rockaway Parkway with a diameter of 33 inches, increasing at Paerdegat to a diameter of 6 ft. 6 in. At Ralph Avenue and Avenue N a 6 ft. 6 in. by 8 ft. box section is adopted as far as Flatbush Avenue.

The West Interceptor receiving sewage from Caisson No. 4 delivered by a 12 in. force main at Avenue Y runs with diameters of from 15 to 33 in. to Flatbush Avenue and Avenue T. From this point the entire 63.8 mgd is

carried by a 6 ft. 6 in. by 12 ft. box sewer to a grit chamber and the Mill Basin Pumping Station.

A part of the sewage received at Paerdegat will have to be pumped. At Mill Basin Pumping Station the elevation of the top inside is —8.06 and the hydraulic grade at times of maximum flow is —10.14. The force main to Barren Island is 6 ft. in diameter and 11,800 ft. long.

Owing to the high degree of treatment required in the other two divisions, fine screening will suffice for the relatively small volume delivered at Barren Island instead of tank treatment. The screening plant is located at the southerly end of the force main and includes means for dewatering the screenings and for their disposal by incineration or in connection with the City's garbage.

A 7 ft. by 5.3 ft. conduit carries the effluent to two 48 in. submerged pipes averaging 900 ft. in length which deliver it at the bottom of Rockaway Inlet.

ESTIMATE.

Construction		$1,923,000
Maintenance and Operation	$110,500	
Fixed Charges	106,800	
Total Annual Charges		$217,300

Middle Division. The interceptor starts at Rockaway Boulevard with a diameter of 4 ft. 3 in. and follows 136th Avenue, North Conduit Avenue, Old South Road, Baker Avenue, Fairfield Avenue and Hendrix Street to the Hendrix Street Pumping Station, where its diameter is 11 ft., its top inside is at elevation —3.53 and the hydraulic grade at times of maximum flow at elevation —7.05. At this point the sewage is passed through grit chambers.

The estimates for the pumping station provide for the installation of pumps and equipment adequate to care for the additional sewage from the area outside that now tributary, as it is assumed that pumps to lift the sewage directly tributary will have to be installed in any case.

The sewage is pumped to a treatment plant through 3-60 in. force mains. In order to avoid the possible depreciation of land likely to be of greatest value in the future on account of the apprehension of a nuisance the oxidizing plant is located midway between the pumping station and the bulkhead line.

After treatment the effluent flows through an effluent conduit consisting of two 7 ft. by 8 ft. 7 in. channels to a gate chamber near the bulkhead line and thence by four lines of 60 in. submerged pipes, 2,000, 3,500, 4,000 and 4,500 ft. long to outlets in Big Channel, where the depth at low tide is from 8 to 10 ft.

ESTIMATE.

Construction		$12,427,000
Maintenance and Operation	$570,900	
Fixed Charges	625,100	
Total Annual Charges		$1,196,000

Eastern Division. The main sewer bringing the sewage along Springfield Boulevard from the direction of Creedmoor begins at Edmonson Avenue with a diameter of 48 in. At Edgewood Avenue a diameter of 60 in. is adopted and this size continues to the pumping station at Rockaway Boulevard. At this point the top inside is at elevation +3.38 and the hydraulic grade at times of maximum flow, elevation +1.88. The sewage brought down Rockaway Boulevard from as far as South Conduit Avenue is also received here and the entire 34 mgd is pumped through 14,950 ft. of 48 in. force main to an oxidizing plant at Jo Cos Marsh.

From the treatment plant the effluent flows by a 6 ft. by 4.1 ft. conduit 750 ft. long and a 48 in. submerged pipe 2,500 ft. long to an outlet in Broad Channel where the water at low tide is about 12 feet deep.

ESTIMATE.

Construction		$2,405,000
Maintenance and Operation	$118,700	
Fixed Charges	122,100	
Total Annual Charges		$240,800

POSSIBLE MODIFICATIONS.

In connection with the several projects which have been described there are certain modifications having more or less merit which have been considered. If a treatment plant is established on Barren Island there would be an advantage in reducing costs of superintendence by consolidating with this any plant for treating the Rockaway sewage (according to Rockaway Projects, B and C). This could be done by jumping through a force main crossing Rockaway Inlet. This force main would be about 16,000 ft. long in the case of Project B and 8,000 ft. long in the case of Project C and laid at a maximum depth at low water of about 40 ft. Objections to this plan lie in the cost of laying this force main so as to be secure with the unstable condition of the sandy bottom of the Inlet and in the additional cost of pumping.

Another plan that has obvious advantages would be to discharge all the Jamaica Bay sewage through a submerged outlet into the ocean at a point about 2 miles south of Rockaway Point. To avoid the fouling of beaches fine screening plants would be required at Barren Island and, for the Rockaway sewage on Rockaway Point. Objection to this plan has been raised on account of the difficulty in constructing and maintaining the outlet, which would be in an exposed location in 40 ft. depth of water at low tide. From

experience in similar works in the Great Lakes and in Boston Harbor these difficulties are not believed to be insurmountable but the initial cost would be so high as to offer little inducement to recommend the adoption of this plan.*

The location of the Eastern Interceptor north of the bay on Flatlands and Fairfield Avenues avoids the necessity of but one inverted siphon: that under Fresh Creek; but its distance from shore will probably make it necessary some time in the future to establish a small auxiliary pumping station between each of the adjacent basins, if these are built as planned.** The advantage of these basins as an aid to the drainage of this flat territory has been mentioned. On the other hand it is believed that with their great length it will be practically impossible to maintain them in a decently clean condition if utilized as intended for shipping. The effect of tidal action in renewing their contents will be increasingly greater the shallower these basins are made. If the bottom were at low tide level, the contents would be (theoretically) entirely renewed twice a day by the tide. But the least depth at the upper end required for commerce will probably be as much as 8 or 10 ft. resulting in the retention of a large volume of practically stagnant water. If, now, these basins could be reduced to, say, a half mile in length the danger of nuisance would be lessened and in addition the interceptor could be so located without the necessity of inverted siphons as to render auxiliary pumping stations unnecessary. The plans, however, contemplate the construction of these basins as now approved by the Department of Docks and Ferries.

There are possibly other minor modifications that may be mentioned here. In order to avoid a nuisance near treatment plants due to septic sewage it may be said that tanks may be covered, as at London and Frankfort; and the same remedy may be applied to sprinkling filters, as applied by our near-by municipality, Mount Vernon. Beyond this there is the possibility of supplying the sewage with oxygen during transit by aeration or otherwise so that it will effectually prevent septicization. The effectiveness of the first two remedies is questioned in the case of very large works and in any case would not affect questions of potential subsequent nuisances due to the effluent, while the efficiency and economic aspects of aeration are somewhat problematical.

A certain appreciable reduction in the putrescible material in the effluent can be readily made by fine-screening the sewage near its source as is done to a certain extent in both Paris and Berlin. This improvement would not appear to be sufficiently important to make it a requisite feature of the recommended project, but it is not amiss to point out that the Riensch-Wurl screens now installed at the 26th Ward Disposal Plant and those which it is under-

*A project similar to this was worked out by the Metropolitan Sewerage Commission to dispose of 157.5 mgd of sewage at 2 points 8,000 ft. from shore. The two 7 ft. 4 in. tunnels with outlets in about 20 ft. depth at low water were estimated to cost about $1,100,000 in 1910.

**Studies of typical areas indicate that the greater part of the areas south of the interceptor can be drained thereto by gravity with moderate alterations in street grade, leaving ultimately but perhaps 1 mgd to be pumped at each of these stations.

stood the Bureau of Sewers proposes to install at Paerdegat serve an excellent purpose in connection with whatever project is selected. It might even be wise to install fine screens at the Jamaica Disposal Plant if this sewage should be carried as far as Barren Island, and also before the Springfield Boulevard Pumping Station, which would reduce the load on an oxidizing plant if established on Jo Cos Marsh.

It is also suggested that, instead of carrying the sewage brought down by the existing Milford Street sewer to a pumping plant at Hendrix Street, a connection be made between this sewer at Wortman Street and the interceptor at Fairfield Avenue by which, with the present system of collection, it may be delivered by gravity.

Selection of Project.

The projects for the areas lying north and those lying south of Jamaica Bay are quite distinct and independent except as to the distribution of the effluent in the bay, so that if each is selected on its own merits and the conditions regarding dilution are satisfactory it is unnecessary that they should be the two shown on the plan with the same letter.

Controlling considerations are those of *efficient drainage, adaptability to early conditions and later development, insurance against objectionable conditions about the works or in the bay and the relative cost.* If the cheapest project will fulfill these conditions, it is the one that should be adopted.

Table XI.

Summary of Estimates for the North District.

Project	Division	Cost of Construction	Total Annual Charges
A	....	$14,295,000	$1,222,000
B	Western	$11,118,000	$942,000
	Eastern	4,301,000	448,700
	Total	$15,419,000	$1,390,700
C	Western	$7,536,000	$698,500
	Eastern	9,228,000	906,700
	Total	$16,764,000	$1,605,200
D	Western	$1,923,000	$217,300
	Middle	12,427,000	1,196,000
	Eastern	2,405,000	240,800
	Total	$16,755,000	$1,654,100

As might be expected, the total annual charges are seen to increase with a decrease in the volume discharged at Rockaway Inlet and the substitution

of more costly oxidizing processes at other points. Except that Project D is slightly less costly than Project C the same rule holds good regarding the cost of construction. On this basis Project A would appear most favorable for adoption. It is, however, open to the objection that the sewage, a part of which would be delivered after a flow of nearly 13 miles before reaching the disposal plant in addition to over 7 more miles to the extreme limits of the district, would be practically sure to arrive at times at the works in a septic and malodorous condition, and liable to cause a nuisance in the vicinity besides resulting in a prompt and considerable demand on the supply of dissolved oxygen in the waters of the Inlet.

The force of these objections grows less with each of the projects from A to D.

The annual charges for Project B, the next in point of economy, are 14 per cent. more than in the case of A.

The maximum distance traveled to the works is about 11 miles in the interceptor and 4 miles more to the most extreme point drained. The time of travel after reaching the interceptor is estimated at 5¼ hours and from the most extreme point it would probably be about 8 hours.

The opinion has been expressed (page 47) that "sewage brought from a distance of over 6 or 8 miles from the centre of population under ordinary conditions of flow and in warm weather is likely to arrive in a stale condition"; that is, it will probably contain little or no dissolved oxygen and be on the verge of becoming septic and ill-smelling.

In Project B 17.9 mgd or but 8.6 per cent. of the total volume taken to Barren Island comes in at the upper end of the interceptor while 73.6 mgd, over a third of the total, enters at Hendrix Street, which is 4.3 miles nearer, or but 6.8 miles from the point of disposal. Considering the velocity of flow, which varies from 2.5 to 3.8 ft. per sec., it is probable that the sewage would reach the plant before becoming putrescent, but that it would not be advisable to commit the City to the ultimate collection of sewage to this point from more remote sources. The above are mean velocities on the completion of the work and there are times, especially in early years, when somewhat lower values may obtain; but by the adoption of two conduits below Hendrix Street and three lines of force main it is believed the assumed velocities may be approximated by using one of these only at first. There seems no reason to suppose that odors from the treatment plant would extend more than 1,000 ft. therefrom or be noticed by persons on vessels passing through Rockaway Inlet.

Another advantage over Project A lies in the discharge of the effluent at two widely separated points. The load on the capacity of the waters at the Inlet would be reduced by 23 per cent., while the oxidized effluent from the Jo Cos Marsh plant would be entirely innocuous.

Project C differs from Project B in carrying all sewage collected at or west of Genesee Street to Barren Island and that collected east of this point

to Jo Cos Marsh. By this plan the sewage collected and disposed of in each Borough would remain practically as it exists to-day.

In Project D the sewage collected between Rockaway Boulevard and Fresh Creek Basin would be treated by oxidation near Hendrix Street. The area lying to the east of Rockaway Boulevard would drain to Jo Cos Marsh and that to the west of Fresh Creek Basin to Barren Island. This, and Project C, are eliminated from further consideration on account of their cost, provided either Project A or Project B is suitable.

In either Project the sewage from Caisson No. 4 near Sheepshead Bay will be carried to Barren Island for treatment.

In order to avoid the early construction of an oxidizing plant on Jo Cos Marsh and in view of the low cost of Project A and, if practicable, of so aerating the sewage in transit as to prevent a nuisance from odors if this should be found necessary, *it is recommended that the first installation shall be constructed along the lines of Project A, providing a gravity connection for sewage brought down the Springfield Boulevard from near Creedmoor. In the event that it should be desired later to adopt Project B the works can then be completed to conform thereto with little extra expense except the abandonment of the aforesaid connection with the Springfield Boulevard Sewer.*

This elastic arrangement has one further advantage. If, in the distant future, there should be any reason to discontinue a discharge of effluent into Rockaway Inlet the entire volume of sewage from the Northern District may be carried by tunnel to an ocean outlet far south of the present location of Rockaway Point.

2. MAIN DRAINAGE OF FAR ROCKAWAY AND THE ROCKAWAY PENINSULA.

Project A.

By this project the sewage from Far Rockaway and the Rockaway peninsula, varying from 20 mgd in winter to a maximum of 28 mgd in summer, is carried to Silver Hole Marsh where it is treated and the effluent discharged into Broad Channel.

Much of the Far Rockaway sewage is at present collected at the disposal plant on Elsmere Street near Hassock Place. Without materially altering the existing lines of collection it is proposed to convert this disposal plant into a pumping station from which a 16-inch force main will be laid in Elsmere Street to Mott Avenue, where it will take in the flow from the existing ejector station No. 2. From this point the sewage will flow by gravity through a sewer, called the Eastern Intercepter, increasing from 3 ft. 2 in. to 4 ft. 4 in. in diameter at Beach 60th Street and taking in the flow from ejector station No. 3 at Beach 32d Street and Far Rockaway Boulevard. At Beach 60th Street it is joined by a similar sewer, called the Western Interceptor, which runs easterly from Beach 146th Street with diameters increasing

from 15 in. to 4 ft. 10 in. The combined flow from both interceptors is then carried by a 6 ft. 6 in. sewer along Beach 60th Street, to Barbadoes Drive where it first passes through a grit chamber and is then pumped under Grass Hassock Channel to an oxidizing plant on Silver Hole Marsh. The effluent is discharged by a submerged outlet into Broad Channel at a depth of 12 feet. Electrically operated pumping stations are located beneath the surface of Rockaway Boulevard at Beach 130th and Beach 90th Streets.

ESTIMATE.

Cost of Construction		$2,452,000
Maintenance and Operation	$136,140	
Fixed Charges	123,960	
Total Annual Charges		$260,100

Project B.

By Project B the entire volume of sewage from the Rockaways will be delivered to a treatment plant on Little Egg Marsh and the effluent discharged in The Raunt.

The sewage of Far Rockaway is pumped and conveyed to Rockaway Beach Boulevard as in Project A but the Eastern Interceptor continues westerly as far as Beach 116th Street where its diameter is 5 ft. 3 in.

The Western Interceptor starts at Beach 146th Street with a diameter of 15 in. and joins the Eastern Interceptor with a diameter of 3 ft. 3 in.

The combined flow from the Eastern and Western Interceptors is then carried along Beach 116th Street in a 6 ft. 2 in. sewer to a pumping station near the bulkhead line where the top inside is at elevation —4.96.

Here, after passing a grit chamber, it is pumped under Beach Channel to Little Egg Marsh, treated by settling in Imhoff tanks and discharged by submerged outlets in about 22 ft. depth of water.

Auxiliary electrically operated pumping stations are located under Beach Boulevard at Beach 85th Street and Beach 136th Street in order to avoid excessive depths of trench in open and saturated soil.

ESTIMATE.

Construction		$1,580,500
Maintenance and Operation	$85,050	
Fixed Charges	80,375	
Total Annual Charges		$165,425

Project C.

Project C contemplates the removal of all the sewage of Far Rockaway and the Rockaway peninsula to a point near Seaside Park where, after treatment, the effluent would be discharged into Beach Channel.

As in Projects A and B the sewage collecting at the existing disposal plant in Far Rockaway is pumped to Mott Avenue and then flows in an inter-

ceptor increasing from 3 ft. 4 in. to 5 ft. 3 in. in diameter as far as Beach 97th Street. Here it is lifted about 6 ft. by automatic electrically-operated pumps and continues with diameters of from 5 ft. 6 in. to 6 ft. 6 in. to Beach 149th Street and thence to a fine screening and pumping plant near the bulkhead line. From this point it is pumped to a submerged outlet about 30 ft. below low water level in Beach Channel.

ESTIMATE.

Construction		$1,512,400
Maintenance and Operation	$71,940	
Fixed Charges	79,118	
Total Annual Charges		$151,058

Project D.

By Project D the sewage of the Rockaways is collected to several convenient and suitable independent points near the bulkhead line where it is treated by sedimentation in Imhoff tanks and discharged in the deepest water available. It is feasible to accomplish this with but three outlets and in order to avoid a multiplication of small plants this is the number that has been assumed.

The sewage of Far Rockaway is collected as in the projects already described and is carried to Beach 69th Street where the diameter of the sewer is 4 ft. 9 in. On the west an interceptor from Beach 74th Street is laid to the same point with diameters of from 10 inches to 15 inches. The combined flow is then carried in a 4 ft. 9 in. sewer to a pumping and sedimentation plant at Beach 69th Street and Bayfield Street where it is treated and pumped to an outlet in Grass Hassock Channel in a depth of 15 ft. of water at low tide.

Between Beach 77th Street and Beach 109th Street the sewage is collected at Beach 96th Street by interceptors from 10 inches to 27 inches in diameter. From this point a 36 inch sewer carries the combined flow to a pumping and sedimentation plant at Beach 96th Street and Beach Channel Drive where it is treated and pumped to an outlet in Beach Channel in a depth of 19th ft. of water at low tide.

From Beach 111th Street to Beach 148th Street the sewage is collected at Beach 129th Street by interceptors from 10 in. to 30 in. in diameter and thence along Beach 129th Street in a 3 ft. 6 in. sewer to a treatment and pumping plant at Beach 129th Street and Beach Channel Drive where it is treated by sedimentation and pumped to an outlet in Beach Channel in a depth of 14 ft. of water at low tide.

ESTIMATE

Construction		$1,311,697
Maintenance and Operation	$64,310	
Fixed Charges	66,638	
Total Annual Charges		$130,948

A fifth project for the Rockaways consisting of a combination of Projects C and D has been considered. By this plan the sewage would be collected to points on Rockaway Beach Boulevard as in Project D, but instead of carrying it to isolated treatment plants near the south shore of the bay it would be pumped at each point into a force main leading from Beach 69th Street to a fine-screening and pumping plant near the bulkhead line on Beach 149th Street and the effluent discharged into Beach Channel, as in Project C. The force main would have diameters of from 36 to 48 inches and, as estimated, would be laid in the same trench as the sewer.

ESTIMATE.

Construction		$1,270,093
Maintenance and Operation	$84,750	
Fixed Charges	65,617	
Total Annual Charges		$150,367

The cost of construction is, therefore, $242,307 less than for Project C and $41,604 less than for Project D, but the total annual charges (which are a truer index of the relative economy of the several projects) are $1,718 more than in Project C and $19,367 more than in Project D, due to the additional cost of pumping. This plan will not be referred to again, although it has sufficient merit to be suggested as worthy of further study as an available alternative to any plan recommended.

POSSIBLE MODIFICATIONS.

Another suggested plan has provided for the discharge in the ocean of the sewage conveniently collected to a point in Edgemere.* The Bureau of Sewer Plan worked out two such plans for the discharge of 16.5 mgd: one at a point 4,000 ft. in 22 ft. of water and the other 7,000 ft. from shore in 28 ft. of water at low tide, after sedimentation. In each case the outfall consisted of a 42 in. cast iron pipe and the cost was $150,000 and $280,000 in the two schemes, respectively.

On December 12th, 1910, Col. W. M. Black, U. S. A., and Prof. Earle B. Phelps in a report to Mr. Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment, recommended the disposal of the Rockaway sewage at three submerged outlets located** in the ocean off Edgemere, Hammel and Neponsit. The report states that:—

*Four plans for a discharge off Edgemere were considered by the Metropolitan Sewerage Commission. In the first 91.5 mgd would be carried after fine screening by an 8 ft. tunnel to an outlet 8,000 ft. off shore in about 33 ft. of water. The cost of this was estimated at $600,000 in 1911. In the second plan 18.6 mgd would be carried after fine screening by a 60 in. cast iron pipe to a point 4,000 ft. from shore where it would be discharged in about 22 ft. of water. The cost of this outlet was estimated in 1911 at $174,500. In the third and fourth plans 38 mgd of tank effluent would be carried by two 60 in. cast iron pipes and discharged 5,300 ft. off shore at a depth of about 26 ft. at low tide. The cost of these outfall pipes for each plan was estimated in 1913 at $300,000. Prices today would undoubtedly be higher.

**Report concerning Location of Sewer Outlets and the Discharge of Sewage into New York Harbor. p. 148.

> "The three outlets along the shore front of the Rockaway section will each be carried about 1,000 ft. off shore into water having a mean depth of 15 feet. Experience elsewhere, notably at Asbury Park and Ocean Grove, has indicated that with suitable provision for the removal of the grosser suspended matter, such a method of disposal may be used without any resulting nuisance. We recommend disposal works at these points, consisting of screening and a short period of detention in hydrolytic tanks, so designed as to clarify the sewage and give a maximum of liquefying action with a minimum of anaerobic putrefaction."

The further investigation of projects involving ocean outlets off Edgemere was abandoned as with the 24 mgd of sewage to be expected from the Rockaways in the future a high degree of clarification would be required to prevent visible evidences of pollution during periods favorable to a northerly drift of the surface water unless the outlet were at a very considerable distance from shore. The danger of this is indicated by inspections made by the Metropolitan Sewerage Commission in 1906 when the City's garbage was being dumped from scows off Scotland Light at a distance of 12 miles from Edgemere.* From Arverne to Far Rockaway considerable garbage was noted all along the shore. This was confirmed by inspections made the same season by the U. S. Life Saving Service who reported regarding the Rockaway shore:

> Aug. 1st to 25th, no garbage; 19th, few decayed lemons; 20th, little garbage, old; 21st, considerable, in decomposed condition; 22nd to Sept. 2nd, no garbage."**

The Rockaway beaches are perhaps the best, and destined to be the most popular, of New York's bathing resorts and it is believed that any plan contemplating the discharge of large volumes of sewage off these shores would meet with determined opposition, even if so treated and discharged as to avoid any appearance of pollution in the water.

With regard to the Far Rockaway area the four projects are identical, assuming the existing system of collection to several ejector or pumping stations. It is suggested that the system can be improved to advantage, with a consequent reduction of the volume to be pumped and a reduction in the sizes shown between Beach 32nd Street and the Far Rockaway Pumping Station, by constructing two branch interceptors from this point, delivering by gravity to the interceptor shown in the plan, one of which will run on Beach 32nd Street and then easterly along Edgemere Avenue and the

*Report Met. Sew. Com. 1910, p. 378. **Idem. p. 385.

ower northerly along Beach 32nd Street. These, however, are not considered in the estimates as they are not essential to the schemes.

SELECTION OF PROJECT.

The following are the estimated costs of each project:

Project	Volume Mgd.	Treatment Kind	At	Construction Cost Million Dollars	Total Annual Charges
A	24	Oxid'n	Silver Hole M.....	2.42	$200,190
B	24	Sedim'n	Little Egg M.....	1.58	165,425
C	24	Screen'g	Neponsit.....	1.51	151,058
D	13.7	Sedim'n	Beach 69th St		
	4.4	"	" 96th "	1.31	130,948
	5.9	"	" 129th "		

NOTE—These estimates exclude expenditures for land and legal expenses.

Project A is seen to cost so much more than the others that it need receive no further consideration. This is on account of the high degree of purification required for an effluent discharged into Broad Channel.

Projects B and C deliver the effluent well down toward the Inlet. The flood current will carry that from Project B up The Raunt; that from Project C up Beach Channel, The Raunt and possibly Big Channel, while it will carry that from the isolated plants to Project D up Beach Channel and in part up Broad Channel. That is to say, the nearer the Inlet the sewage is discharged the greater the dilution by the flood current (although if carried up The Raunt by Project B it would be well dispersed in the interior of the bay) while on the ebb a larger proportion will be carried directly to the Ocean and never return. For this reason (as in Project D of the Northern District) it has been deemed sufficient to provide for fine screening in the case of Project C while sedimentation is called for in Projects B and D.

There is no reason to suppose that Project B, if carried out, would not be quite as satisfactory as Project C or Project D, but as the latter two are less costly to construct and in the matter of annual charges, and as a plant located on Little Egg Marsh would not be as accessible as if on the Rockaway peninsula, this may also be eliminated.

Comparing Projects C and D, Project D costs $200,700 less to construct and $20,110 less per annum; any one of the three separate parts can be constructed by itself when required and so defer a certain part of the first cost, and, finally by concentrating the sewage near the bulkhead line the properties in that neighborhood will receive more thorough drainage.*

On the other hand, Project D will make necessary the acquisition of more land for treatment plants (not included in the estimates), while Project C with its three pumping stations and a single treatment plant will be

*There are limited areas near the water front in all four projects that will not receive effective drainage, but in Project D this is practically limited to the area lying west of Norton Basin. It is assumed that when, if ever, more adequate drainage is required in such areas resort will be made to small automatic ejector stations.

more easily supervised than Project D with its four pumping stations and three treatment plants.

Although the dilution of the effluent from Project D would be ample to avoid a nuisance, the condition of the water along the shores would be less clean than by the adoption of Project C.

Project C has the further advantage that, if it should ever be thought desirable and feasible to carry the sewage to Barren Island for treatment, and so reduce the number of plants, this could be done, while by the adoption of Project D it would be impracticable.

It is believed that on the whole *Project C, with a discharge after fine-screening into Beach Channel, possesses the greater merit and its adoption is therefore recommended.*

PROGRESSIVE CONSTRUCTION.

The demand for better sewerage in the Rockaways is believed to be such that the system south of the bay may be constructed at one time, either by sections to be all completed at the earliest possible date or else successively and without interruption, but such construction will of necessity begin at the point of disposal at the westerly end. In either case operation could begin with the completion of the disposal plant and the adjoining section.

But in the case of the Northern District the works will be of such magnitude and their need be so different at different localities that some programme for progressive construction is desirable. Three schemes have, therefore, been worked out to determine which was most advantageous.

In each scheme only such parts of the work are comprised in any one installation as will be required for the ensuing decade, by which time the next installation will have been completed and ready for service. The connection with Caisson No. 4 on the west is assumed to be made in 1940 by which date it has been assumed in the estimate that the entire work will be completed.

In the first scheme a single conduit of the interceptor would be constructed from Mill Basin to Paerdegat, with the necessary provision for pumping, treatment and outlets to serve for the decade 1920-1930. A temporary oxidation plant would be provided at Hendrix Street with a single conduit of interceptor to Genesee street and another oxidation plant near the present Jamaica Disposal Plant with an interceptor and collecting sewer to Springfield Boulevard. It is assumed that the former of these plants will be abandoned in 1930 and one conduit of the interceptor extended from Paerdegat to Hendrix Street, while the Jamaica plant will be discontinued in 1940 with the extension and completion of the interceptor.

In the second scheme the interceptor is carried as far as Genesee Street in the first installation, avoiding the construction of a temporary plant at Hendrix Street.

In the third scheme the interceptor is carried the whole distance to Rockaway Boulevard by 1920.

For comparison, a fourth estimate is given on the assumption that the complete work is constructed at once adequate for the needs 40 years hence.

A plan comprising temporary disposal at Paerdegat is also possible but it is not believed that at this location any mode of treatment short of oxidation will prove acceptable, as this would involve so large an expenditure as to have no advantage over disposal at Barren Island.

By *Scheme* 1 there would be provided at once:

(1) One of the nine outlet pipes, one of the two channels of the outfall conduit, treatment plant for 18.4 of the 272 mgd, one of the three force mains, pumping station with two of the six pumps, the grit chamber and one of the two conduits of the interceptor from Mill Basin to Paerdegat, at a cost of $2,376,000

(2) One temporary treatment plant for 42.3 mgd, and one of the two conduits of the interceptor from Hendrix Street to Genesee Street, at a cost of 2,379,000

(3) A temporary treatment plant for 41 mgd, the complete interceptor from the temporary plant at Jamaica to Rockaway Boulevard and the collecting sewer from Rockaway Boulevard to Springfield Boulevard, at a cost of 2,456,000

By 1930 the temporary treatment plant at Hendrix Street would be abandoned and there would be installed in addition to the above, three outlet pipes, treatment plant extended to care for 82.9 additional mgd, one pumping unit, addition to grit chamber at Mill Basin, one conduit of interceptor from Paerdegat to Hendrix Street, with the complete siphon and one section of the grit chamber at Fresh Creek, at a cost of..... 3,333,000

By 1940 the temporary treatment plant for Jamaica would be abandoned and the work would be completed at an additional cost of..... 8,657,000

By *Scheme* 2 there would be provided at once:

(1) Four of the nine outlet pipes, one of the two channels of the outlet conduit, treatment plant for 101 of the 272 mgd, one of the three force mains, pumping station with three of the six pumping units, parts of the Mill Basin and Fresh Creek grit chambers and one of the two conduits of the interceptor from Mill Basin to Genesee Street, at a cost of 6,337,000

(2) Temporary treatment plant for Jamaica for 41 mgd, the complete interceptor from this plant to Rockaway Boulevard and the collecting sewer from Rockaway Boulevard to Springfield Boulevard at a cost of 2,456,000

By 1940 the temporary treatment plant for Jamaica would be abandoned and the work would be completed at an additional cost of..... 8,657,000

By *Scheme* 3 there would be provided at once:

Four of the nine outlet pipes, one of the two channels of the outfall conduit, treatment plant for 127 of the 272 mgd, two of the three force mains, pumping station with four of the six pumping units, part of the Mill Basin and the Fresh Creek grit chambers, one of the two conduits of the interceptor from Mill Basin to Panama Street, including the complete siphon under Fresh Creek, the complete interceptor from Panama Street to Rockaway Boulevard and the collecting sewer from Rockaway Boulevard to Springfield Boulevard, at a cost of..... 8,895,000

By 1930 there would be added:

Two outlet pipes, the second channel of the outfall conduit, treatment for 48.4 mgd, the balance of the two grit chambers and the Eastern interceptor, at a cost of..... 4,965,000

By 1940 the work would be completed at a cost of..... 2,233,000

It has been assumed that the cost of the temporary oxidizing plants will be $36,000 per mgd. capacity and that the flow in each decade is uniformly at the rate reached in the middle of the decade. The total expenditures up to the year 1950 will then be as in table XII.

TABLE XII.

Total Expenses for Progressive Construction and Operation for the Northern District required for Each Stage of Construction, according to

PROJECT A

assuming payment to be made in the decade following construction.

Interest 4½%. Total fixed charges on permanent works: Mechanical Equipment 9%; other construction 5%.

	Scheme 1	Scheme 2	Scheme 3	Scheme 4
*Cost of Permanent Works to 1920..	$3,763,000	$7,096,000	$8,895,000	$14,295,000
Cost of Temporary Works to 1920..	3,448,000	1,697,000	....	....
Total Cost to 1920.....	7,211,000	8,793,000	8,895,000	14,295,000
*Fixed Charges 1920-1930.....	5,439,000	4,910,000	4,536,000	7,278,000
*Maint. and Op'n, 1920-1930. Based on average flow 109 mgd.....	2,405,000	1,873,000	1,878,000	1,878,000
Total Charges, 1920-1930.....	7,844,000	6,783,000	6,414,000	9,156,000
Cost of Permanent Works, 1920 to 1930	$3,333,000	$	$7,965,000	$ ....
Cost of Temporary Works, 1920 to 1930	....	....	....	....
Total Cost, 1920 to 1930.....	3,333,000	....	7,965,000	....
*Fixed Charges, 1930-1940.....	4,910,000	4,910,000	7,019,000	7,278,000
*Maint. and Op'n 1930-1940. Based on average flow 149 mgd.....	2,590,000	2,590,000	2,474,000	2,474,000
Total Charges, 1930-1940.....	7,500,000	7,500,000	9,493,000	9,752,000
Cost of Permanent Works, 1930 to 1940	$8,814,000	$8,814,000	$2,233,000	$ ....
Cost of Temporary Works, 1930 to 1940	....	....	....	....
Total Cost, 1930-1940.....	8,814,000	8,814,000	2,233,000	....
*Fixed Charges, 1940-1950.....	8,070,000	8,070,000	8,173,000	7,278,000
*Maint. and Op'n, 1940-1950. Based on average flow 221 mgd.....	3,509,000	3,509,000	3,509,000	3,509,000
Total Charges, 1940-1950.....	11,579,000	11,579,000	11,682,000	10,787,000
Totals to 1950—				
*Cost of Permanent Works.....	$15,910,000	$15,910,000	$16,093,000	$14,295,000
Cost of Temporary Works.....	3,448,000	1,697,000	.....	.....
Total Cost of Works.....	19,358,000	17,607,000	16,093,000	14,295,000
*Fixed Charges	18,419,000	17,890,000	19,728,000	21,834,000
*Maintenance and Operation.....	8,504,000	7,972,000	7,861,000	7,861,000
Total Charges	26,923,000	25,862,000	27,589,000	29,695,000

*Includes cost of interest upon, or maintenance of the collecting sewer from Springfield Boulevard to Rockaway Boulevard.

From this table it appears in the first place that there would be no advantage in constructing the interceptor as far as the Jamaica plant for the first installation, and, furthermore, that Scheme 2, involving construction of one barrel of the interceptor at the beginning as far as Genesee Street, is the cheapest plan to follow. The gross expenditures for fixed charges, operation and maintenance would be $6,783,000 for the first installation, $7,500,000 between 1930 and 1940 and $11,579,000 between 1940 and 1950.

In financing an improvement of this kind the capital costs will be assessed against the benefited property soon after the completion of the work and the City reimbursed thereby for moneys advanced. In this respect the situation differs from that found in many cities undertaking important improvements where the cost is met by an issue of long term bonds. Therefore, so far as the City's expenditures are concerned, there will be no added burden for interest charges. Amortization charges, which may be considered in the light of depreciation losses, will be virtually met in the same way as maintenance and operating charges; that is, from the annual budget, except in such special cases as when met by the issue of special revenue bonds or corporate stock.

Now the capital cost being assessed directly on the property is a burden that unimproved property finds it difficult to meet, and it so happens that a large part of the benefited area, especially that in the vicinity of the interceptor, consists at present of waste marsh-land. The effect of an excessive assessment on such property would not only be an immediate burden to the owner but would result in a material depreciation of the property, retarding its natural development.

The capital costs, to be paid for by the property, and the maintenance and operation charges, to be paid for by the City, are therefore, for practical purposes, of prime consideration.

Now, if we reject Schemes 3 and 4 as obviously too costly for consideration, it follows that it would not be economical to extend the interceptor as far as the Jamaica plant at first, and we have for Schemes 1 and 2 the following sums required from each of the above sources (property owner and City at large) up to 1950.

TABLE XIII.

Cash Expenditures for Progressive Construction and Operation for the Northern District required for Each Stage of Construction, according to

Project A.

	Capital Cost Paid for by Property Owners		Operation and Maintenance* Paid for out of Tax Budget.	
	Scheme 1	Scheme 2	Scheme 1	Scheme 2
1918 to 1920	$7,211,000	$8,793,000	.....	.....
1920 to 1930	3,333,000	.....	$2,405,000	$1,873,000
1930 to 1940	8,814,000	8,814,000	2,590,000	2,590,000
1940 to 1950	.....	.....	3,509,000	3,509,000
Total	$19,358,000	$17,607,000	$8,504,000	$7,972,000

For a precise comparison depreciation charges should be added to these figures.

The construction of definite installments by decades as in Tables XII and XIII is assumed merely to determine the most favorable scheme of development. Practically extensions would only be made as required and it is impossible to forecast this far in advance. The important conclusions drawn are (1) that the plan of constructing works from Barren Island to Genesee Street at first with a temporary treatment plant at the Jamaica Disposal Plant at an estimated first cost of $8,793,000 would theoretically be the most economical for the City to carry out, but (2) that the plan most favorable to both the City and the property owner consists for practical reasons in constructing at this time as far as Paerdegat only, with temporary treatment plants at both the 26th Ward and the Jamaica Disposal works at an estimated first cost of $7,211,000, or $1,582,000 less than by Scheme 2, but with charges for operation by 1925 of $53,200 per annum higher than by that scheme. The operating charges after the abandonment of the temporary treatment plant at Hendrix Street in 1930 would be the same.

DISPOSAL OF SLUDGE AND SCREENINGS.

The question of sludge disposal is an important and often a difficult matter to provide for in a satisfactory manner. In the recommended plan the sludge will be from Imhoff tanks and, therefore, it will be digested and inoffensive. The volume produced per day at Barren Island from 272 mgd of sewage may be provisionally estimated at:

$$10.5 \times \text{population served in thousands} = 10.5 \times 2150 = 22575 \text{ cu. ft.} = 836 \text{ cu. yds.}^*$$

The wet sludge, of perhaps 80 per cent. moisture, can probably be disposed of for some years by running onto low lands in the neighborhood for

*Sewage Sludge. Elsner, Spillner, Allen. p. 228.

filling. Transportation to sea and dumping off Scotland Light can always be availed of at this site, as practised at London and other of the large seaboard cities of Great Britain, but there seems no good reason to incur the large expense for carriage by this method with inoffensive Imhoff sludge and large areas nearby waiting to be filled in.

If drying beds of 0.4 sq. ft. per capita are provided the area required by 1955 will amount to $\frac{2{,}150{,}000 \times 0.4}{43{,}560} = 20$ acres and if reduced by air-drying 60 per cent. there will be produced 335 cu. yds. per day of dried sludge —that is, material containing 60 or 65 per cent. of moisture. This can readily be transported by wagons or by rail to more distant points for filling-in land, for which it is entirely suitable. There is also the bare possibility that with such a large and uniform output of a material containing a certain percentage of nitrogen and fats some way may be found to utilize these in the future, but the outlook at the present time is not promising.†

Another product that may be mentioned is the gas given off by the decomposition of the sludge in the tanks. This varies greatly with the temperature and with the details of operation At the Peachtree Creek, Atlanta, plant there is obtained 3,750 cu. ft. per mg of sewage which is utilized for heating purposes, etc., about the works.‡

If, in this cooler climate, we allow 3,000 cu. ft. per mg, the Barren Island plant would ultimately furnish over 800 thousand cu. ft. per day. The gas, which is chiefly Methane, contains from 587 to 839 British thermal units.§ The potential value of this source of energy for purposes of power, heating and lighting at the plant and the Mill Basin Pumping Station is therefore a matter to be borne in mind.

The disposal of screenings from the Neponsit plant is a simple matter but one requiring constant attention to prevent odors during warm weather. Screenings being richer in fats and manurial ingredients than Imhoff sludge offer greater promise for utilization provided the volume produced is sufficient to warrant the somewhat elaborate plant, comprising presses, percolators, driers, etc. With a plant handling 20 to 24 mgd, the least costly method of disposing of the screenings effectively and without offense will

	Percentage of Dried Material				
	Nitrogen	Fats	Authority		
Atlanta	1.25	6.11	Eng'g & Cont'g		Dec. 13, 1916
Philadelphia	1.2	6.5	Sewage Sludge		p. 224
Recklinghausen	1.74	6.87	"	"	p. 180
Essen	1.22	4.95	"	"	p. 181
Bochum	1.18	6.12	"	"	p. 181

†Engineering and Contracting, Vol. XLVI, p. 534.

§This is about half that obtained from plain settled sludge in experiments by the Massachusetts State Board of Health in 1900. Sewage Sludge, p. 248.

probably be the most advantageous. Such methods are (a) dewatering and incineration at a high temperature at the site of the plant, or (b) collection and disposal (daily in summer) with the garbage of the vicinity.

The volume to be disposed of is somewhat problematical, but, if we assume 0.1 cu. yd. per 1,000 of the resident population, there would be produced by 1950 12 cu. yds. containing perhaps 75 per cent. moisture per day.

Resulting Dilution.

It remains to be seen whether the effluent from the treatment plants, after full development, will be sufficiently diluted in the waters of the bay.

If, in Project A, we consider that five-sixths of the effluent discharged into the ebb current does not return from the ocean we have $7/12 \times 295 =$ 172 million gallons or 22.9 million cu. ft. of sewage diluted by $2 \times 2{,}308.7 =$ 4,617 million cu. ft. of flood flow in 25 lunar hours = 4,460 million cu. ft. per day, giving a dilution ratio of 194 :1.

If, instead of terms of sewage flow, we consider the average dilution in cu. ft. per second for every 1,000 population, we have:

$$\text{Average cu. ft. per sec. due to tidal prism} = \frac{2 \times 2{,}308{,}700{,}000}{89{,}428} = 51{,}635.$$

Equivalent population whose sewage enters the bay

$$7/12 \times 2{,}270{,}000 = 1{,}320{,}000$$

Cu. ft. per sec. per 1,000 population, 39.1.

According to Dr. D. D. Jackson from 20 to 70 dilutions are required, according to circumstances, to secure a stable mixture of raw sewage and water.

Mr. George W. Fuller is of the opinion* that with American sewages containing from 50 to 100 ppm. of non-settling solids "when uniformly diluted with 25 volumes of river water there would be no objectionable turbidity due to the sewage."

Mr. F. P. Stearns states** that "water containing as much nitrogenous matter in a state of change as is found in 4½ to 7 per cent. of sewage added to clean river water, retains its oxygen and does not give off odors." Also, "that with more than 7 cu. ft. per sec. of stream flow per 1,000 persons there was almost certain to be no offensive odor or offensive appearance produced."

When sewage is clarified by sedimentation the effluent will require less dilution than raw sewage.

Mr. A. P. I. Cottrell states† "It was found (in the river Usk) that the dilution of 1 in 100 of settled sewage with ordinary sea water enabled the sea water to dispose of the sewage without harm to fish life."

Mr. Langdon Pearse believes the dilution required for settled sewage

*"Sewage Disposal," p. 216.
**Report of Committee on Charles River Dam, 1903, p. 90.
†The Surveyor, August 11, 1911, p. 203.

to be not over 70 per cent. that required for raw sewage, and Mr. George W. Fuller says that, whereas from 3 to 7 cu. ft. per sec. is required to dilute raw sewage of one thousand persons, 2½ cu. ft. per sec. (or 5 cu. ft. per sec. in the case of manufacturing cities and impure water) will suffice in the case of settled sewage.

If we conclude from the above statements that a dilution of 50 volumes of bay water to one of raw sewage, or of 7 cu. ft. of water per sec. for each 1,000 persons contributing, is sufficient, the ratio of dilution 194 : 1 found for Project A or 39 cu. ft. per 1,000 persons is more than ample for settled sewage.

These figures, however, presuppose a thorough diffusion in the waters of the bay. Unfortunately, the larger the volume concentrated at one point the less the opportunity for thorough diffusion and the greater the probability of local pollution due to the depletion of oxygen in the water. The danger of this is increased in the case of a septic sewage. According to Mr. A. P. Folwell* "observations indicate that, the greater the quantity of sewage that is discharged the greater is the area (of pollution) covered the area increasing in more than direct proportion to the sewage discharge." In illustration he cites an experiment made at Boston by a discharge of raw sewage from Moon Island at the rate of 35 to 40 mgd. "The discoloration was evident for 1⅛ miles and covered about 350 acres during ebb tide and 300 acres during flood tide." Now in spite of a discharge through multiple outlets at the bottom instead of at one point near the surface as at Boston, and the fact that the sewage from Barren Island would have been settled, its much greater volume (over seven times that at Boston) and its discharge into the confined waters of the Inlet and Bay render it probable that for a large area near the outlet the pollution of the water will be evident to the sight if not to the smell. As to odors a personal trip across the sewage field during times of discharge at Moon Island in warm weather is sufficient to convince one of the difference between the discharge of large and small volumes of septic sewage at one point.

Of existing outlets perhaps those of London at Barking and Crossness in the Thames are more nearly similar to that proposed in Rockaway Inlet than can be found elsewhere. At Barking, when visited, about 225 mgd and at Crossness 180 mgd were being discharged after chemical precipitation. The effluents, although discolored, were otherwise unobjectionable in appearance, but caused a marked depletion of the dissolved oxygen in the stream.** The Chemist at Crossness, Mr. J. W. H. Biggs, writes regarding the situation February 10th, 1914: "I beg to inform you that it is not possible to take a more serious view that we do with reference to the low percentage of oxygen found in the Thames."

It is understood that in warm weather this has practically reached zero.

*"Sewerage," 11th Edition, p. 394.

**The Thames here has a tidal range of about 20 ft. and a net flow toward the sea of 19 million cu. ft. per day. Trans. Am. Soc. C. E. Vol. LXXVIII, p. 1054.

although the absence of suspended matter leads one to suppose the waters of the river to be in a cleaner condition than they actually are.

While the waters for dilution for the effluents of suggested oxidizing plants at Hendrix Street and on Jo Cos Marsh are quite limited in volume, the effluents themselves should have a high stability and so no apprehension of a nuisance need be held as to disposal at these points.

To sum up, its seems probable, as already stated, that the discharge of nearly 300 mgd of tank effluent into or near Rockaway Inlet will not prove entirely satisfactory. If it should turn out to be satisfactory, there would be a material saving in the adoption of Project A. Before it became necessary to construct the second conduit of the interceptor there would have been an opportunity to observe the effect of the effluent on the waters of the Inlet and, if then deemed advisable, to modify the method of disposal. For this any one of three courses lies open for selection:

1st. The completion of the work along the lines of Project B with oxidation on Jo Cos Marsh.

2nd. The extension of the outfall by a submerged tunnel leading to an ocean outlet far from shore.

3rd. The substitution of oxidation treatment for sedimentation on Barren Island.

The first of these would involve little expense beyond that incurred by the adoption of Project B at this time, but if, for any reason, this should not be acceptable, an ocean outlet after fine screening would probably be preferable to oxidation on Barren Island. The additional cost is roughly estimated as follows:

ESTIMATE.

Construction—	
Fine Screening Plant	$648,000
Extension of Force Main—	45,000
7,000 ft. 11′ 8″ Tunnel, Barren Island to Rockaway Point and 11,000 ft. 12′ 2″ Tunnel, Rockaway Point to Outlet	3,821,000
Submerged Outlet	205,000
Total	$4,719,000
Contingencies 15%	708,000
Total	$5,427,000
Annual Charges—	
Operation and Maintenance	$129,600
Fixed Charges	271,350
Total	$400,950

The total annual charges for oxidation on Barren Island, if sprinkling filters were adopted, would be nearly twice this amount.

If discharge into the ocean were adopted, the outlet would be about 2 miles south of Rockaway Point in 40 ft. of water at low tide.

Recommendations.

It is recommended that Project A be adopted for the Northern District with a possible reversion to Project B, if it should later be found desirable, and that Project C be adopted for the Rockaway District.

The sewage of a few marginal areas will ultimately require pumping at small automatically operated stations, but otherwise the drainage will be thorough and effective. Treatment will be carried on at a minimum number of plants, with a corresponding minimum expense for overhead charges. At any approach to unsatisfactory conditions in the waters of the Inlet there will be the option (1) of completing the work on the lines of Project B; (2) of carrying the entire output of sewage by one or more tunnels to submerged outlets in the Ocean off Rockaway Point; or (3) if the activated sludge process should be found profitable to adopt, this can readily be carried out either at Barren Island or Jo Cos Marsh or at both localities. Meanwhile the work can be constructed and paid for piecemeal as occasion demands.

These results are obtained by an expenditure during the next 25 years of some $20,870,000, by which time the annual charges will amount to $1,373,000, which is equivalent to $12.83 per million gallons or to 60½ cents per annum for each person served.

Appended to this report is a list of the drawings submitted therewith and details of estimates for the several projects.

In conclusion acknowledgment is due to the following gentlemen for information furnished in connection with the preparation of this report:

Col. F. V. Abbot, U. S. A., Engineer in Charge, 2nd District, New York.
Captain Thomas M. Robins, U. S. A., Recorder, New York Harbor Line Board.
Dr. D. D. Jackson, Columbia University, New York.
Dr. Hugh S. Cumming, Surgeon in Charge, Investigation of Coastal Waters, U. S. Public Health Service.
Dr. Francis A. Carmelia, Ass't Surgeon, U. S. Public Health Service.
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Mr. John K. McCormick, Deputy Chief, Division of Fish and Game, New York State Conservation Commission.
Mr. N. S. Sprague, Chief Engineer, Bureau of Construction, Department of Public Works, Pittsburgh, Pa.
Mr. Lucius P. Brown, Director, Bureau of Food and Drugs, New York City Department of Health.
Mr. Harold Keen, Inspector of Shellfisheries, New York City Department of Health.

Respectfully submitted,

Kenneth Allen,
Engineer of Sewage Disposal.

APPENDIX

DETAILS OF ESTIMATES

Estimate of Cost—Northern District—Project A.

		General Data.	Estimated Cost.
Area drained—acres		43,833	....
Population		2,150,000	....
Sewage—Mgd.		272	....
COST OF CONSTRUCTION			
Interceptors			
West	Diameters	15" to 33"	....
	Length	8770'	$90,100
East	Diameters	8'-0" to 2-10'x14.5'	....
	Length	55,390'	6,850,020
Siphon	No. and diameter	4-66"	....
	Length	500'	139,880
Grit Chamber	Location	Fresh Creek	133,000
Pumping Station	Name	Mill Basin	....
	Max. Capacity—Mgd.	450	....
	Lift, mean-max.	25.86'-30.25'	720,000
Force Mains	Location	Knapp Ave.	....
	No. and diameter	1-12"	....
	Length	1000'	2,900
	Location	Flatbush Ave.	....
	No. and diameter	3-7'-0"	....
	Length	11,000'	618,200
Treatment Plant	Kind	Sedimentation	3,536,000
Outfall Conduit	Length	860'	40,700
Outlet Pipes	No. and diameter	9-48"	....
	Length-average	900'	300,000
			$12,430,800
Contingencies—15%			1,864,200
Total			$14,295,000

ANNUAL CHARGES

Maintenance of interceptors	$6,000
Pumping	266,900
Treatment	221,300
Total Maintenance and Operation	$494,200
Fixed Charges—Mechanical Equipment 9%, Balance 5%	727,800
Total Annual Charges	$1,222,000

ESTIMATE OF COST—NORTHERN DISTRICT—PROJECT B.

DIVISION	EASTERN		WESTERN	
	General Data.	Estimated Cost.	General Data.	Estimated Cost.
Area drained—acres	16,780		27,683	
Population	366,000		1,704,000	
Sewage-Mgd.	62.8		208.4	
COST OF CONSTRUCTION				
Intercepters				
West Diameters			15" to 33"	
Length			6770'	$80,100
Diameters	48"		5'-3" to 4-8.5'x14'	
Length	6130'	$100,600	42,740'	5,322,640
Siphon No. and Diameter			3-60"	
Length			500	104,150
Grit Chambers			Fresh Creek	94,520
Pumping Station—Name	Springfield Blvd.		Mill Basin	
Max. Capacity-Mgd.	100		350	
Lift mean-max	55.3'—64.3'	160,000	29.1'- 38.9'	360,000
Force Mains—Location	Springfield Blvd.		Knapp Ave.	
No. and diameter	2-48"		1-12"	
Length	14,900'	430,000	1800'	2,900
Location			Flatbush Ave.	
No. and diameter			3-6'-0"	
Length			11,000'	319,000
Treatment Plant—Kind	Oxidation	1,626,000	Sedimentation	2,299,000
Outfall Conduit—Length	750'	12,000	860'	40,700
Outlet Pipes—No. and diameter	2-48"		7-66"	
Length average	1800'	105,000	900'	225,000
		$3,740,200		$9,668,010
Contingencies—15%		560,000		1,449,990
Total		$4,301,000		$11,118,000
Grand Total			$15,419,000	
ANNUAL CHARGES				
Maintenance of Interceptor	$800		$5,000	
Pumping	126,700		230,000	
Treatment	103,200		140,300	
		$230,700		$377,300
Fixed Charges—Machinery 9%—Balance 5%		218,000		564,900
Total Annual Charges		$448,700		$942,000
Grand Total			$1,390,700	

DIVISION	EASTERN		WESTERN	
	General Data.	Estimated Cost	General Data.	Estimated Cost
Area drained—acres	24,054	....	19,779	....
Population	916,000	....	1,334,000	....
Sewage—Mgd.	118.6	....	152.6	....
COST OF CONSTRUCTION				
Interceptors: West Diameters	....	....	15" to 33"	....
Length	....	....	8770'	$90,100
East Diameters	3'-6" to 8'-6"	....	4'-9" to 2-7.5'x12.3'	....
Length	23,440'	$1,201,000	32,630'	3,215,670
Siphon No. and diameter	....	....	3-60"	....
Length	....	....	300'	104,130
Grit Chambers	....	....	Fresh Creek	90,440
Pumping Station—Name	Springfield Blvd.	....	Mill Basin	....
Max. Capacity—Mgd.	200	....	200	....
Lift mean-max.	36.0' - 64.5'	330,000	33.8' - 45.4'	440,000
Force Mains—Location	Springfield Blvd.	....	Knapp Ave.	....
No. and diameter	4-48"	....	1-12"	....
Length	14,930'	900,000	1000'	2,900
Location	....	....	Flatbush Ave.	....
No. and diameter	....	....	3-5'-0"	....
Length	....	....	11,000'	430,000
Treatment Plant—Kind	Oxidation	5,337,000	Sedimentation	1,904,000
Outfall Conduit—Length	750'	16,600	900'	30,000
Outlet Pipes—No. and diameter	4-48"	....	5-48"	....
Length average	1000'	210,000	900'	130,000
		$8,024,600		$6,553,360
Contingencies—10%		1,203,400		982,740
Total		$9,228,000		$7,536,000
Grand Total			$16,764,000	
ANNUAL CHARGES				
Maintenance of Interceptor	$2,300	....	$3,900	....
Pumping	242,400	....	198,200	....
Treatment	194,800	....	111,400	....
		9439,400		$313,500
Fixed Charges—Machinery 9%—Balance 5%		467,300		385,000
Total Annual Charges		$906,700		$698,500
Grand Total			$1,605,200	

ESTIMATE OF COST—NORTHERN DISTRICT—PROJECT D.

DIVISION	EASTERN General Data.	EASTERN Estimated Cost.	MIDDLE General Data.	MIDDLE Estimated Cost.	WESTERN General Data.	WESTERN Estimated Cost.
Area drained—acres	10,700	....	21,410	....	12,223	....
Population	180,000	....	1,478,000	....	492,000	....
Sewage—Mgd.	34	....	173.4	....	63.8	....
COST OF CONSTRUCTION						
INTERCEPTOR						
WEST—Diameters	....	....	....	....	15" to 33"	....
Length	....	....	....	....	8,770'	$90,100
Diameters	5'-0"		4'-3" to 11'-0"		33" to 6.5'x12'	
Length	10,050'	$140,800	31,010'	$1,961,700	17,930'	781,200
PUMPING STATIONS—Name	Springfield Blvd.	....	Hendrix St.	....	Mill Basin	....
Max. capacity—Mgd.	60	....	300	....	135	....
Lift—mean—max.	49.8' - 59.6'	100,000	44.7'-45.4'	200,000	29.8'-35.8'	210,000
FORCE MAINS—Location	Springfield Blvd.	....	Hendrix St.	....	Knapp Ave.	....
No. and diameter	1-48"		3-6'-0"		1-12"	
Length	14,950'	225,000	4530'	215,000	1000'	2,900
Location	....	....	....	....	Flatbush Ave.	....
No. and diameter	....	....	....	....	1-6'-0"	
Length	....	....	....	....	11,800'	211,400
TREATMENT PLANT—Kind	Oxidation	1,530,000	Oxidation	7,803,000	Screens	289,000
OUTFALL CONDUIT—Length	750'	12,000	1,700'	76,300	800'	14,300
OUTLET PIPES—No. and diameter	1-48"		4-5'-0"		2-48"	
Length—average	2500'	75,000	3,300'	550,000	900'	55,000
		$2,091,800		$10,806,000		$1,672,900
Contingencies—15%		313,300		1,621,000		250,410
Total		$2,405,000		$12,427,000		$1,923,000
Grand Total				$16,755,000		
ANNUAL CHARGES						
Maintenance of Interceptor	$1,000		$3,000		$2,000	
Pumping	62,900		282,900		73,500	
Treatment	55,000		285,000		35,090	
		$118,700		$570,900		$110,300
Fixed Charges						
Machinery 9%—Balance 5%		122,100		625,100		10,100

Fixed Charges			
Machinery [illegible]—Balance [illegible]	132,100	625,100	110,500
Total Annual Charges	$240,800	$1,196,000	106,800
Grand Total		$1,654,100	$217,300

ESTIMATE OF COST—ROCKAWAY DISTRICT—PROJECTS A, B AND C.

Area drained—acres	3,510
Population—resident	120,000
Population—max. transient	400,000
Sewage—Mgd.—Summer	24
Sewage—Mgd.—Winter	20

COST OF CONSTRUCTION

PROJECT	A General Data.	A Estimated Cost.	B General Data.	B Estimated Cost.	C General Data.	C Estimated Cost.
INTERCEPTORS						
Length	38,000'	....	35,100'	....	35,900'	....
Diameters	8" to 6'-6"	$770,300	8" to 6'-2"	$759,874	3'-4" to 6'-6"	$1,030,08[illegible]
PUMPING STATIONS						
Number	Four	....	Four	....	Three	....
Total capacity	89 Mgd.	....	101 Mgd.	....	95 Mgd.	....
Lift	7.8' to 39.6'	114,000	5.2' to 25.7'	114,300	6.1' to 18.0'	94,125
FORCE MAINS from						
Far Rockaway Pump. Sta.	16"-1575'	11,000	16"-1575'	11,000	16"-1575'	11,000
Ejector Station No. 3	16"-650'	5,300	16"-650'	5,300	16"-650'	5,300
To Treatment Plant	48"-3700'	90,200	2-30"-2200'	68,200	....	....
TREATMENT PLANT	Silver Hole		Little Egg			
Location	Marsh	....	Marsh	....	Neponsit	....
Kind	Oxidation	1,080,000	Sedimentation	312,000	Screening	134,000
OUTLET PIPE				....		
No. and diameter	1-4'-6"	....	1-4'-0"	....	1-4'-0"	....
Length—average	2200'	61,600	3760'	103,700	1400'	40,600
		$2,132,400		$1,374,374		$1,315,107
Contingencies—15%		319,600		206,156		197,273
Total		$2,452,000		$1,580,530		$1,512,400

ANNUAL CHARGES

Maintenance of Interceptor	$4,600		$4,350		$3,900	
Pumping	97,034		69,200		52,710	
Treatment & Sludge Disposal	34,500		11,500		15,330	
		$136,134		$85,050		$71,940
Fixed Charges—Machinery	$3,060		$3,033		$7,869	
Balance	120,900		77,342		71,249	
		123,960		80,375		79,118
Total Annual Charges		$260,094		$165,425		$151,058

Estimate of Cost—Rockaway District—Project D.

Area drained—acres 3,510
Population—resident 120,000
Population—max. transient 400,000
Sewage—Mgd.—Summer 24
Sewage—Mgd.—Winter 20

COST OF CONSTRUCTION

DIVISION	EASTERN		MIDDLE		WESTERN	
	General Data.	Estimated Cost.	General Data.	Estimated Cost.	General Data.	Estimated Cost.
Sewage—Mgd. in Summer	13.7	....	4.4	....	5.9	....
Interceptors						
Diameters	8" to 4'-9"	....	8" to 3'-0"	....	8" to 3'-6'	....
Length	19,240'	$394,588	9,190'	$114,999	12,070'	$181,962
Pumping Stations						
Number	Two	....	One	....	One	....
Total Capacity	37	....	12	....	16	....
Lift	16.3' to 18.0'	43,600	18.5'	26,200	19.8'	29,500
Force Mains						
Far Rockaway Pump. Sta.	16"-1575'	11,000	....	....	....	....
Ejector Station No. 3	16"-650'	5,300	....	....	....	....
Treatment Plant						
Location	Brant Pt.	....	Seaside	....	Neponsit	....
Kind	Sedimentation.	178,100	Sedimentation	57,200	Sedimentation	76,700
Outlet Pipes						
No. and diameter	1-36"	....	1-20"	....	1-24"	....
Length	550'	10,725	400'	3,480	640'	7,232
		$643,313		$201,879		$295,414
Contingencies—15%		96,497		30,282		44,312
Total		$739,810		$232,161		$339,726
Grand Total			$1,311,697			

ANNUAL CHARGES

Maintenance of Interceptor	$2,240		$920		$1,200	
Pumping	27,305		7,855		10,990	
Treatment & Sludge Disposal	8,016		2,430		3,354	
		$37,561		$11,205		$15,544
Fixed Charges—Machinery	$1,294		$486		$590	
Balance	36,272		11,338		16,658	
		37,566		11,824		17,248
Total Annual Charges		$75,127		$23,029		$32,792
Grand Total			$130,948			

List of Drawings Submitted with this Report.

Plate VII. Project A, Map.

Plate VIII. " " North District, Profile of Interceptors.

Plate IX. " " Rockaway District, Profile of Interceptors.

Plate X. " B, Map.

Plate XI. " " North District, Profile of Interceptors.

Plate XII. " " Rockaway District, Profile of Interceptors.

Plate XIII. " C, Map.

Plate XIV. " " North District, Profile of Interceptors.

Plate XV. " " Rockaway District, Profile of Interceptors.

Plate XVI. " D, Map.

Plate XVII. " " North District, Profile of Interceptors.

Plate XVIII. " " Rockaway District, Profile of Interceptors.

Plate XIX. Map of Recommended Project.

(Here follow Plates I, II and III. also Plates VII to XVII inclusive) and Map of Recommended Project

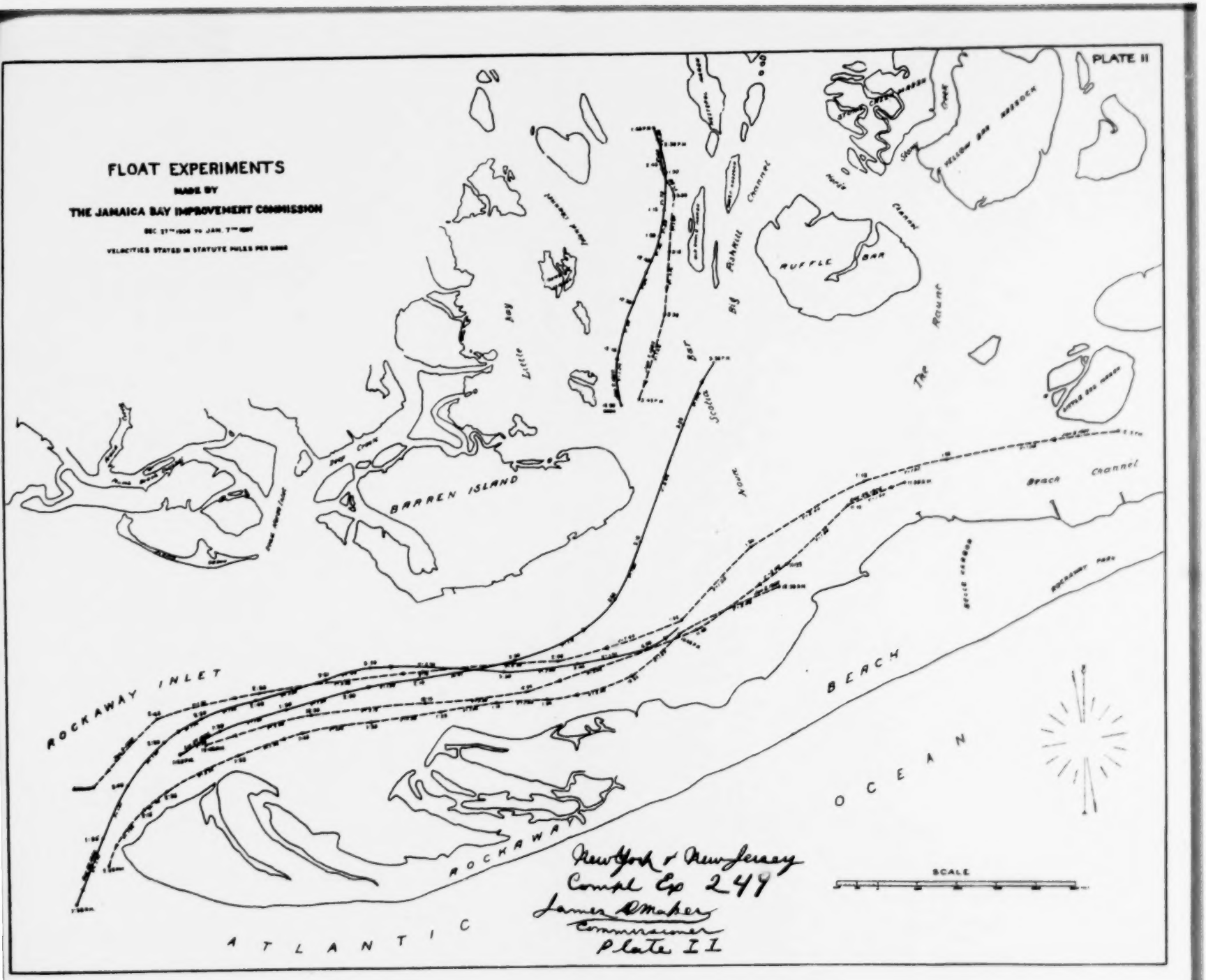
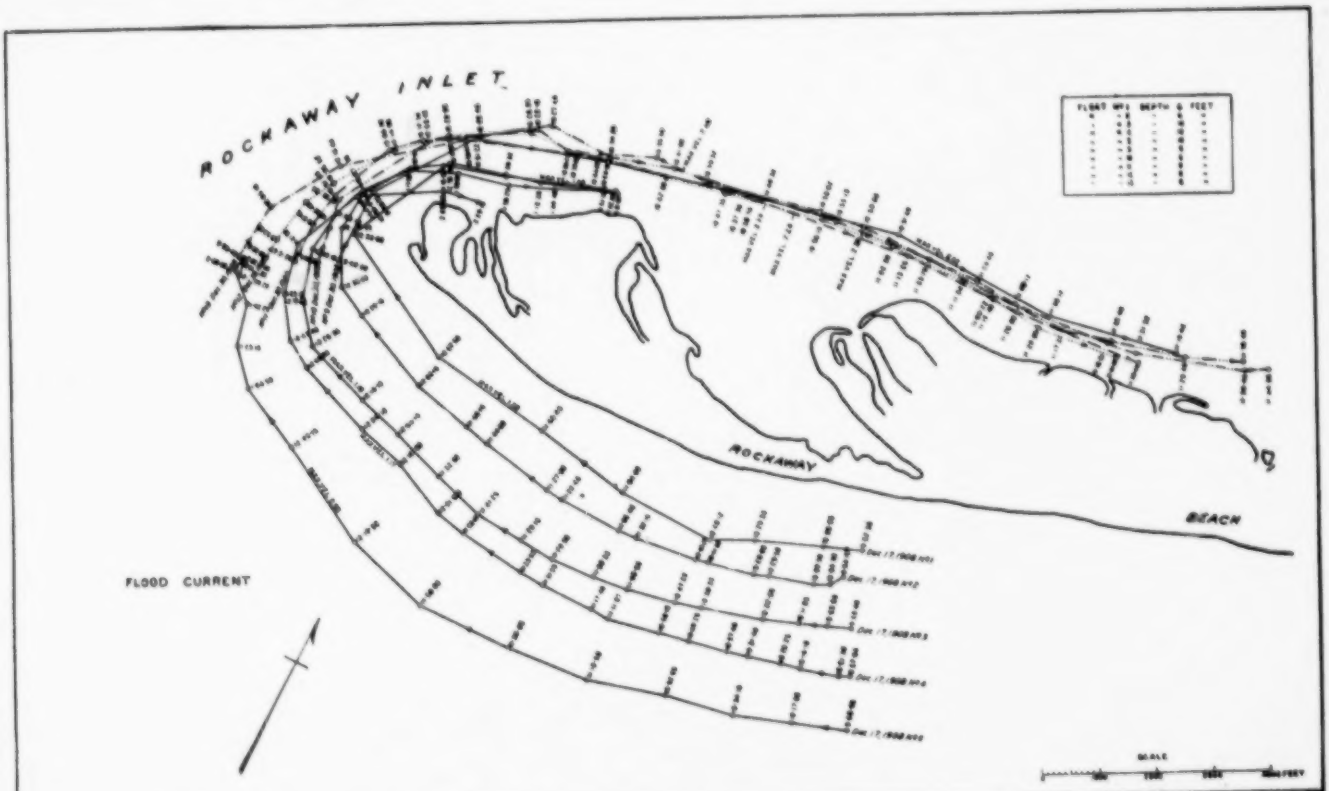
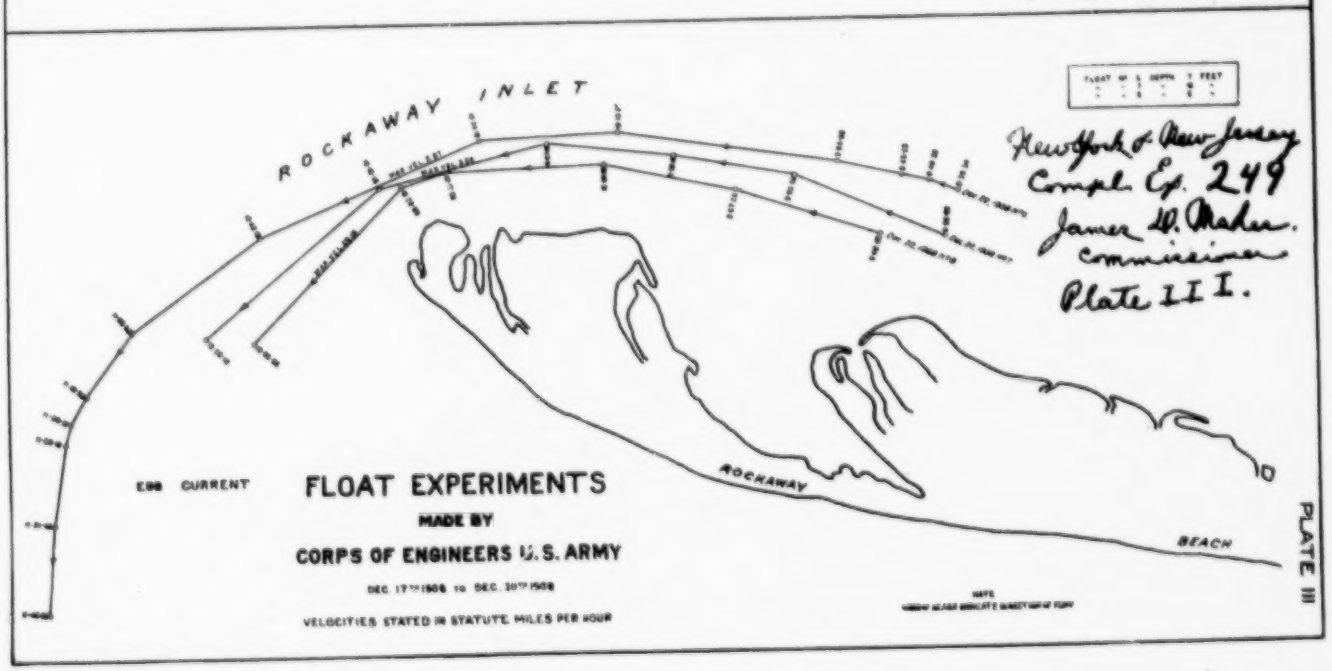


PLATE II
FLOAT EXPERIMENTS
MADE BY
THE JAMAICA BAY IMPROVEMENT COMMISSION
VELOCITIES STATED IN STATUTE MILES PER HOUR
BARREN ISLAND
ROCKAWAY INLET
ROCKAWAY BEACH
ATLANTIC OCEAN
SCALE
New York & New Jersey
Compl Ex 249
James D Maher
Commissioner
Plate II





New York & New Jersey
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Commissioner
Plate III.

PLATE III

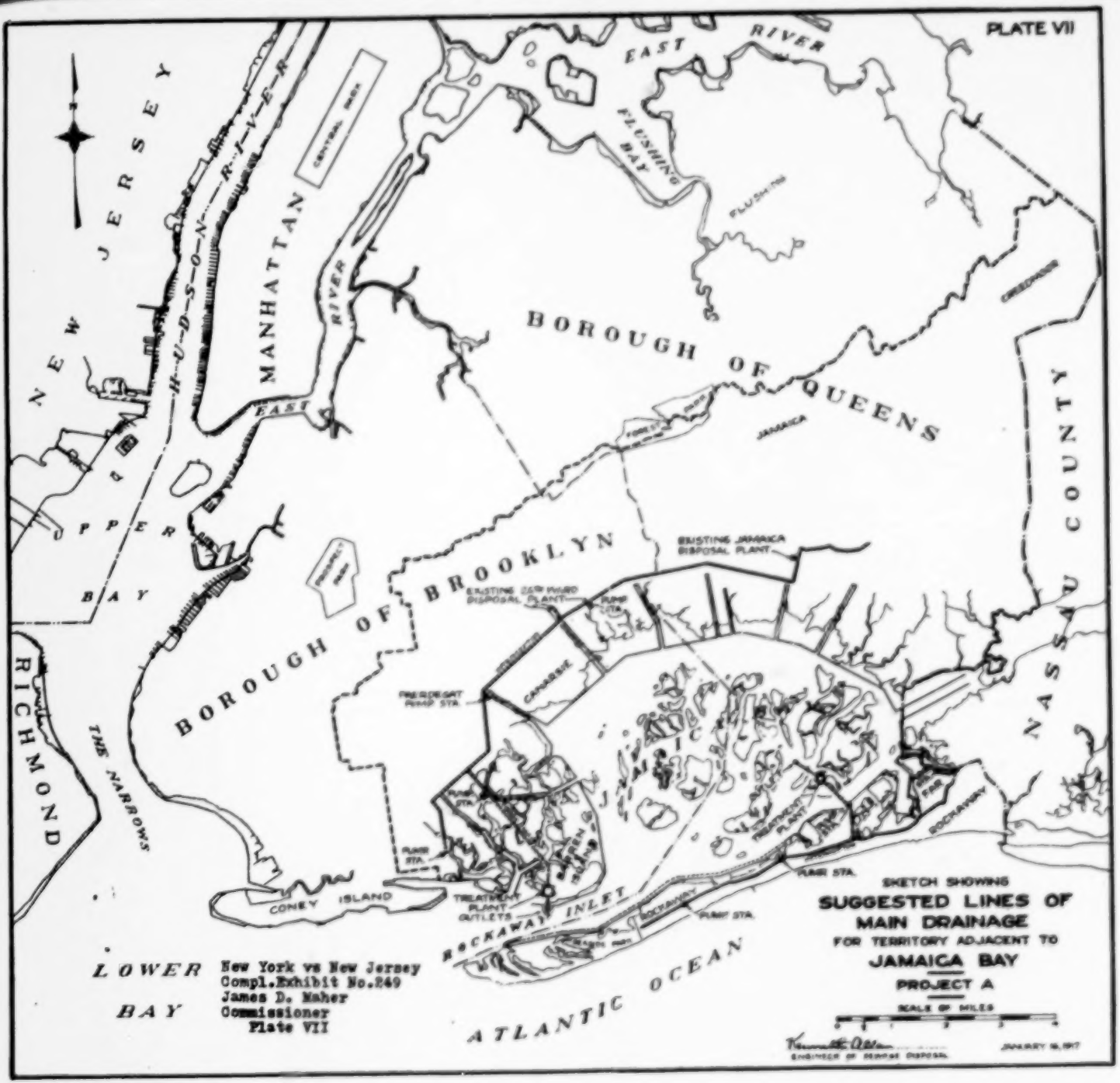
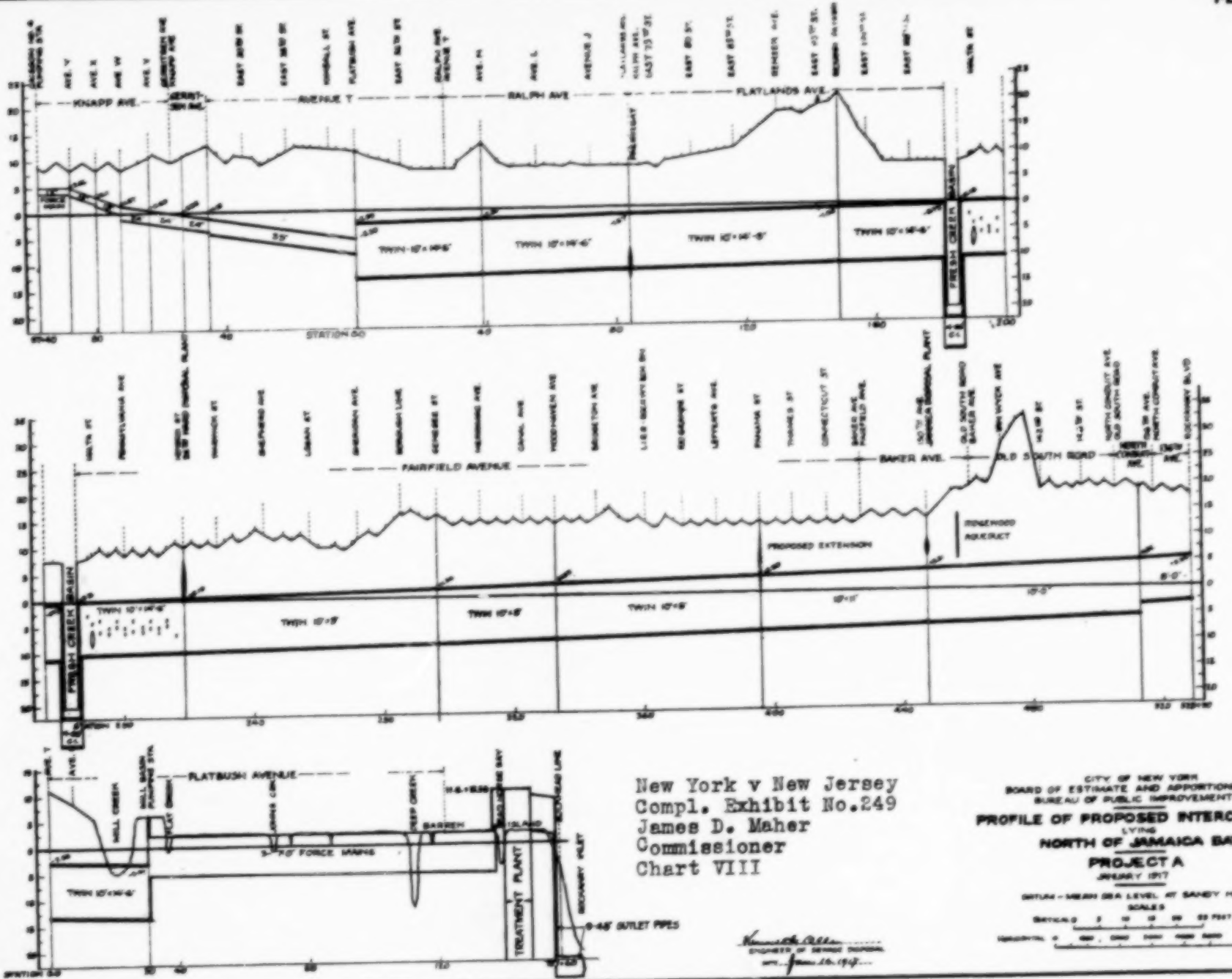


PLATE VII
NEW JERSEY
HUDSON RIVER
MANHATTAN
CENTRAL PARK
EAST RIVER
FLUSHING BAY
FLUSHING
BOROUGH OF QUEENS
JAMAICA
CREEDMOOR
NASSAU COUNTY
UPPER BAY
BOROUGH OF BROOKLYN
EXISTING JAMAICA DISPOSAL PLANT
EXISTING 26TH WARD DISPOSAL PLANT
PUMP STA.
CANARSIE
PREDEGAT PUMP STA.
RICHMOND
THE NARROWS
CONEY ISLAND
TREATMENT PLANT OUTLETS
ROCKAWAY INLET
ROCKAWAY
TREATMENT PLANT
ATLANTIC OCEAN
LOWER BAY
New York vs New Jersey
Compl.Exhibit No.249
James D. Maher
Commissioner
Plate VII
SKETCH SHOWING
SUGGESTED LINES OF
MAIN DRAINAGE
FOR TERRITORY ADJACENT TO
JAMAICA BAY
PROJECT A
SCALE OF MILES
ENGINEER OF SEWAGE DISPOSAL

PLATE VIII



New York v New Jersey
Compl. Exhibit No.249
James D. Maher
Commissioner
Chart VIII

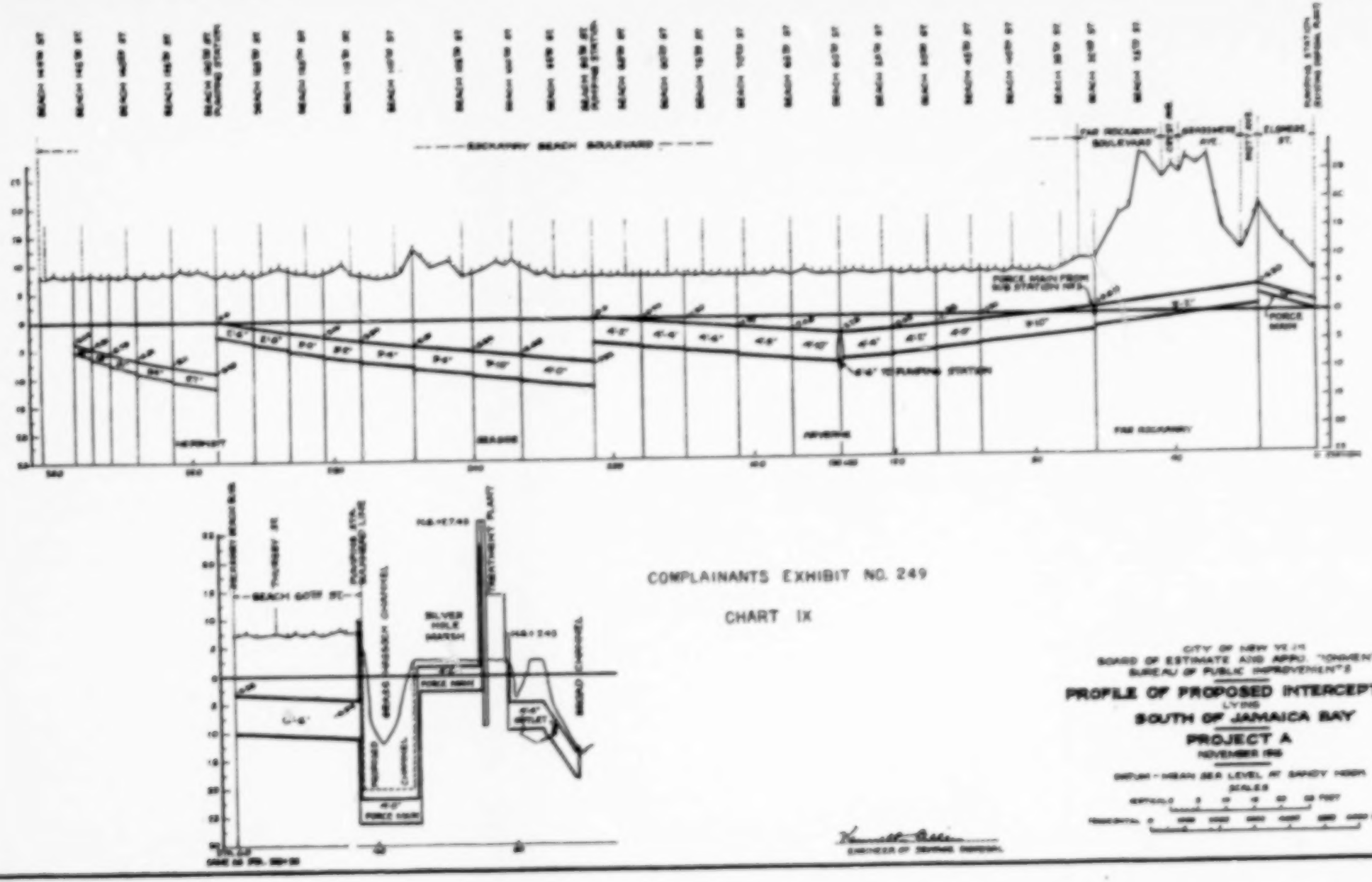
CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

PROFILE OF PROPOSED INTERCEPTORS
LYING
NORTH OF JAMAICA BAY
PROJECT A
JANUARY 1917

DATUM - MEAN SEA LEVEL AT SANDY HOOK
SCALES

ENGINEER OF SEWAGE DISPOSAL

PLATE IX



COMPLAINANTS EXHIBIT NO. 249

CHART IX

CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

PROFILE OF PROPOSED INTERCEPTORS

LYING

SOUTH OF JAMAICA BAY

PROJECT A

NOVEMBER 1935

DATUM - MEAN SEA LEVEL AT SANDY HOOK

SCALES

VERTICAL 0 5 10 15 20 25 FEET

HORIZONTAL 0 1000 2000 3000 4000 5000 6000 FEET

ENGINEER OF SEWAGE DISPOSAL

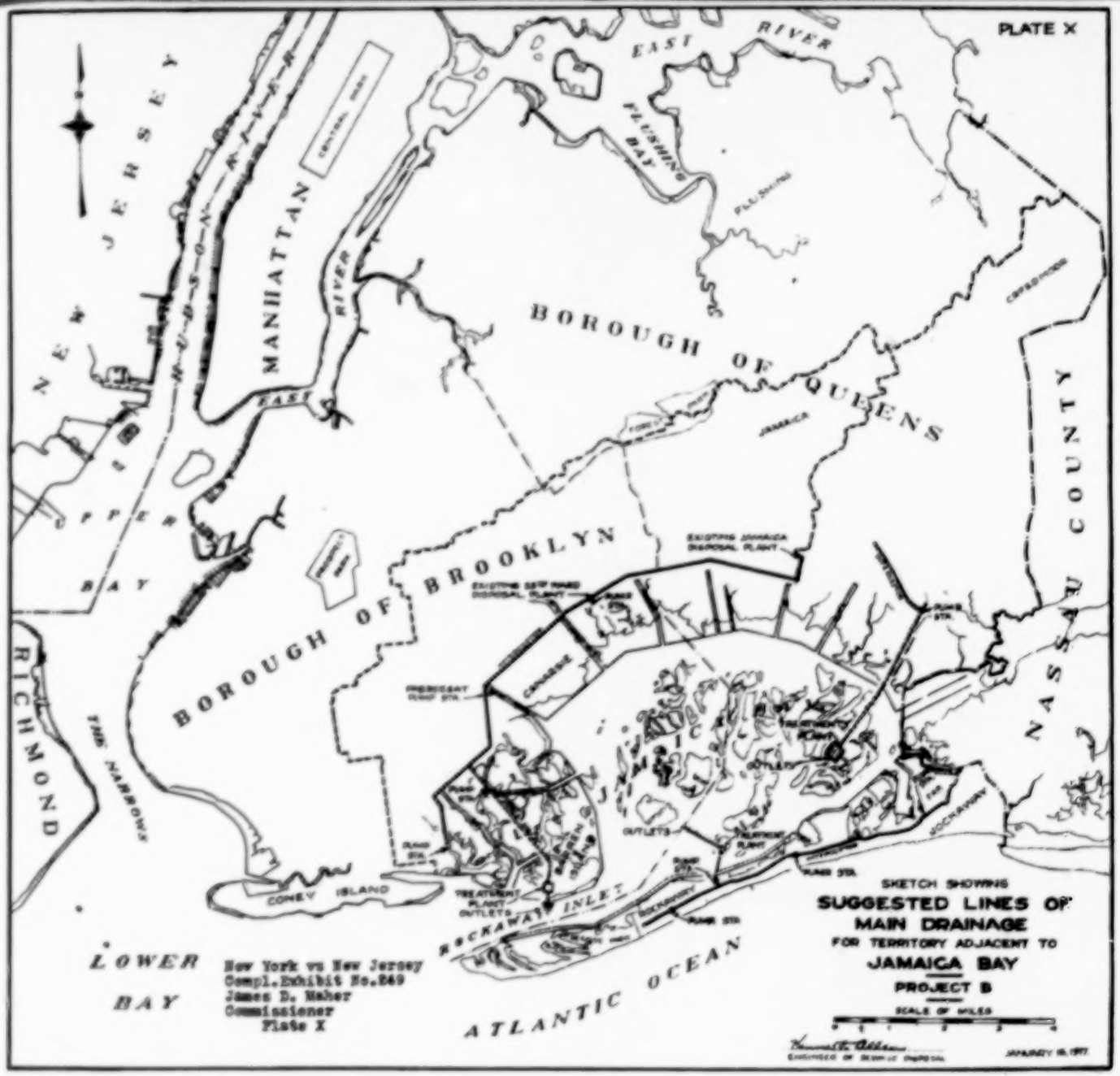
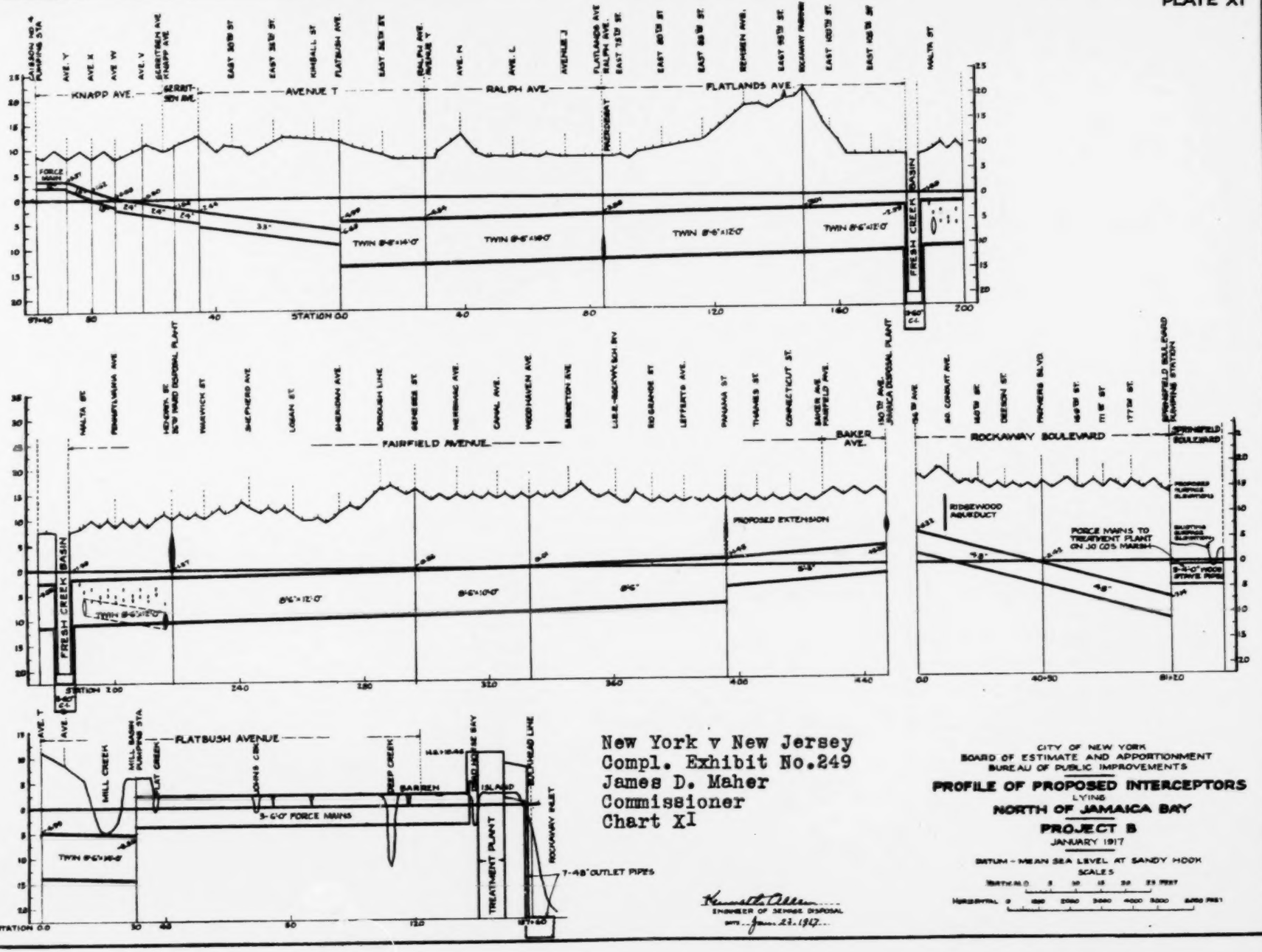


PLATE X
EAST RIVER
NEW JERSEY
HUDSON RIVER
MANHATTAN
EAST RIVER
FLUSHING BAY
BOROUGH OF QUEENS
BOROUGH OF BROOKLYN
NASSAU COUNTY
UPPER BAY
RICHMOND
THE NARROWS
CONEY ISLAND
ROCKAWAY INLET
LOWER BAY
ATLANTIC OCEAN
OUTLETS
SKETCH SHOWING
SUGGESTED LINES OF
MAIN DRAINAGE
FOR TERRITORY ADJACENT TO
JAMAICA BAY
PROJECT B
SCALE OF MILES
JANUARY 15, 1917
New York vs New Jersey
Compl. Exhibit No. 849
James D. Maher
Commissioner
Plate X

PLATE XI



New York v New Jersey
Compl. Exhibit No.249
James D. Maher
Commissioner
Chart XI

Kenneth Allen
ENGINEER OF SEWAGE DISPOSAL
DATE June 23, 1917

CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

PROFILE OF PROPOSED INTERCEPTORS

LYING

NORTH OF JAMAICA BAY

PROJECT B

JANUARY 1917

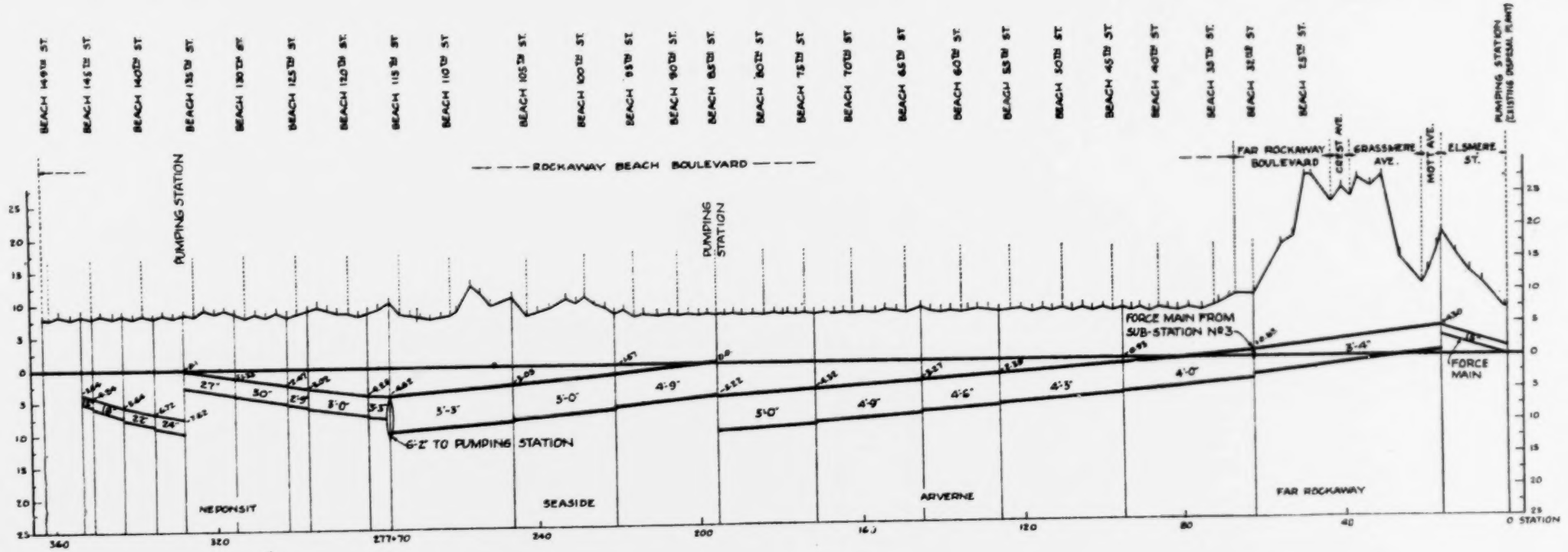
DATUM - MEAN SEA LEVEL AT SANDY HOOK

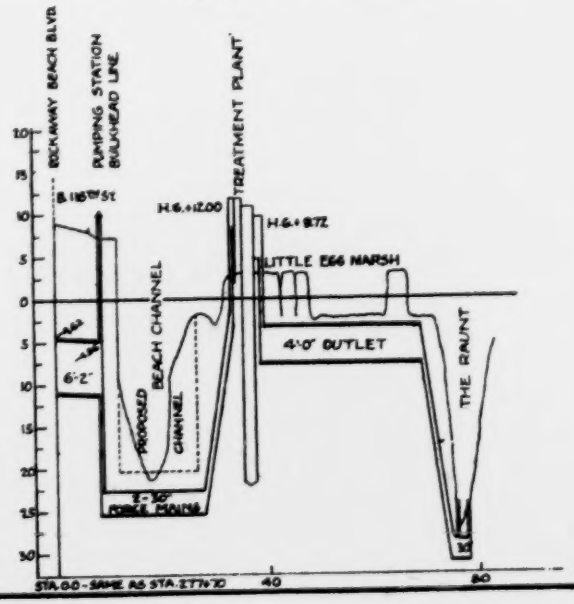
SCALES

VERTICAL 0 5 10 15 20 25 FEET

HORIZONTAL 0 1000 2000 3000 4000 5000 6000 FEET

PLATE XII





COMPLAINANTS EXHIBIT NO. 249

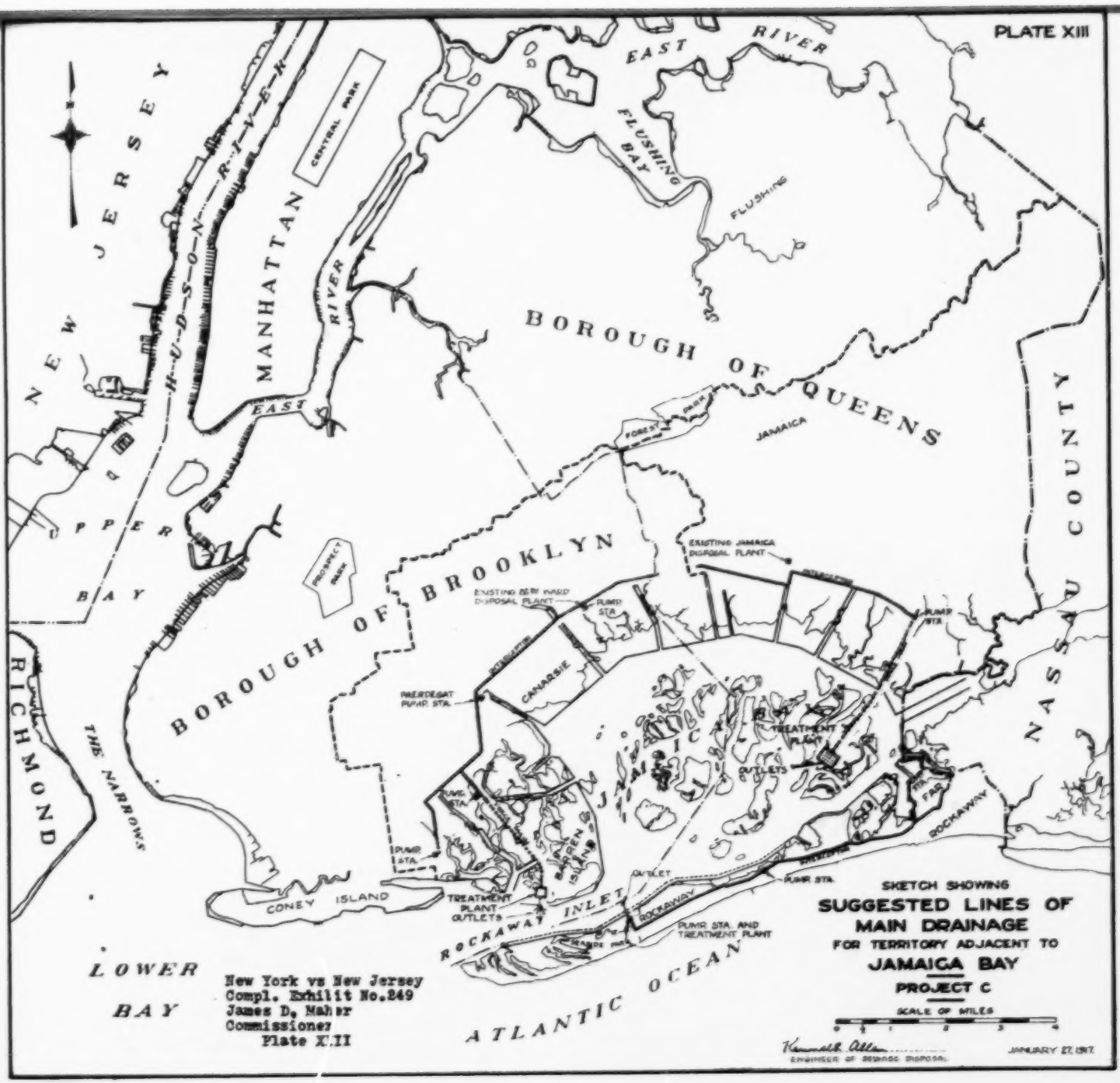
CHART XII

CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

PROFILE OF PROPOSED INTERCEPTORS
LYING
SOUTH OF JAMAICA BAY
PROJECT B
DECEMBER 1916

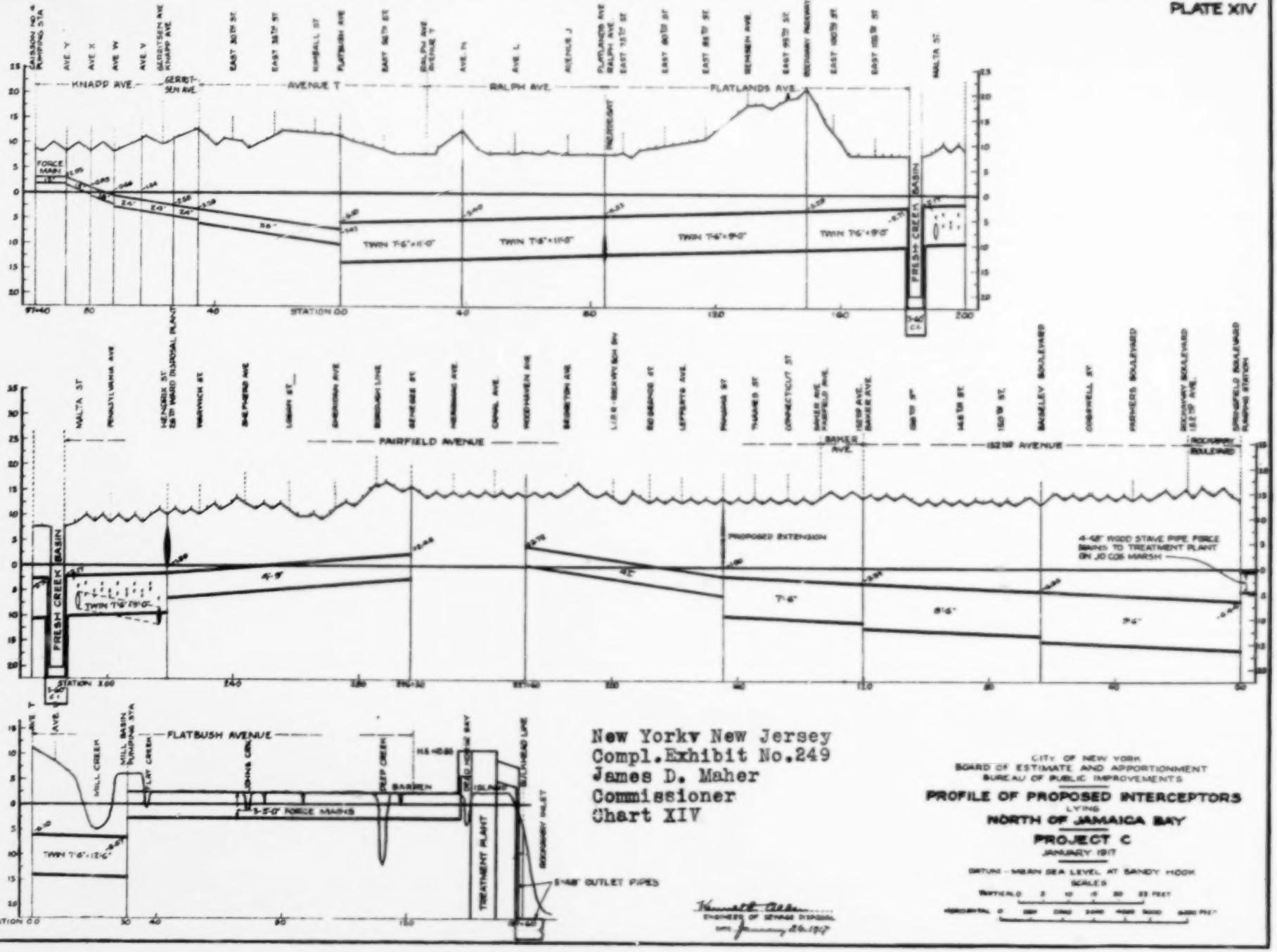
DATUM - MEAN SEA LEVEL AT SANDY HOOK
SCALES
VERTICAL 0 5 10 15 20 25 FEET
HORIZONTAL 0 1000 2000 3000 4000 5000 6000 FEET

Kenneth Allen
ENGINEER OF SEWAGE DISPOSAL



New York vs New Jersey
Compl. Exhibit No.249
James D. Maher
Commissioner
Plate X.II

PLATE XIV



New York v New Jersey
Compl. Exhibit No. 249
James D. Maher
Commissioner
Chart XIV

CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

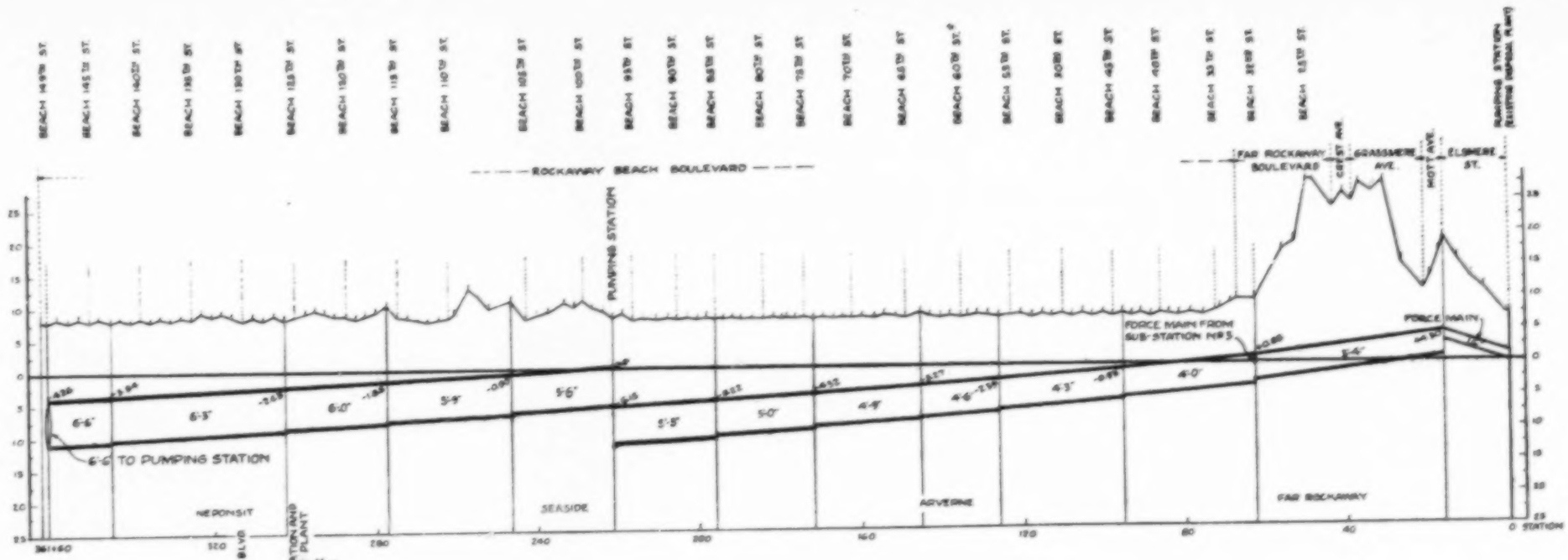
PROFILE OF PROPOSED INTERCEPTORS
LYING
NORTH OF JAMAICA BAY
PROJECT C

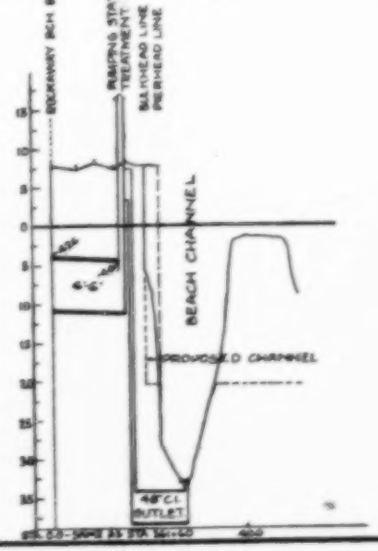
JANUARY 1917

DATUM - MEAN SEA LEVEL AT SANDY HOOK
SCALES
VERTICAL 0 5 10 15 20 25 FEET
HORIZONTAL 0 1000 2000 3000 4000 5000 6000 FEET

ENGINEER OF SEWAGE DISPOSAL
DATE January 26, 1917

PLATE XV





COMPLAINANTS EXHIBIT NO. 249

CHART XV

CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

PROFILE OF PROPOSED INTERCEPTORS

LYING

SOUTH OF JAMAICA BAY

PROJECT C

DECEMBER 1916

DATUM - MEAN SEA LEVEL AT SANDY HOOK

SCALES

VERTICAL 0 5 10 0 50 55 FEET

HORIZONTAL 0 1000 2000 3000 4000 5000 6000 FEET

Kenneth Allen
ENGINEER OF SEWAGE DISPOSAL

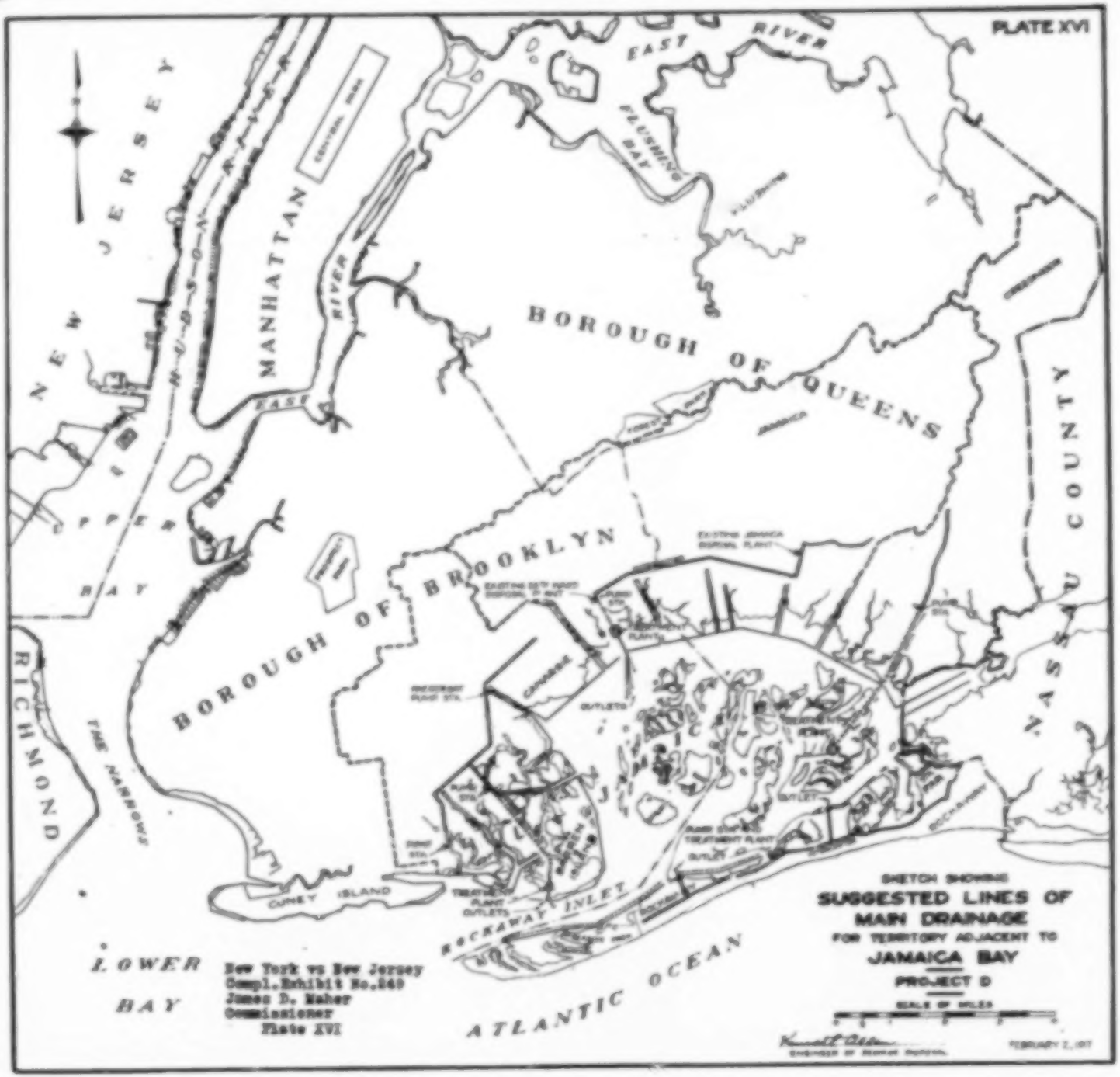
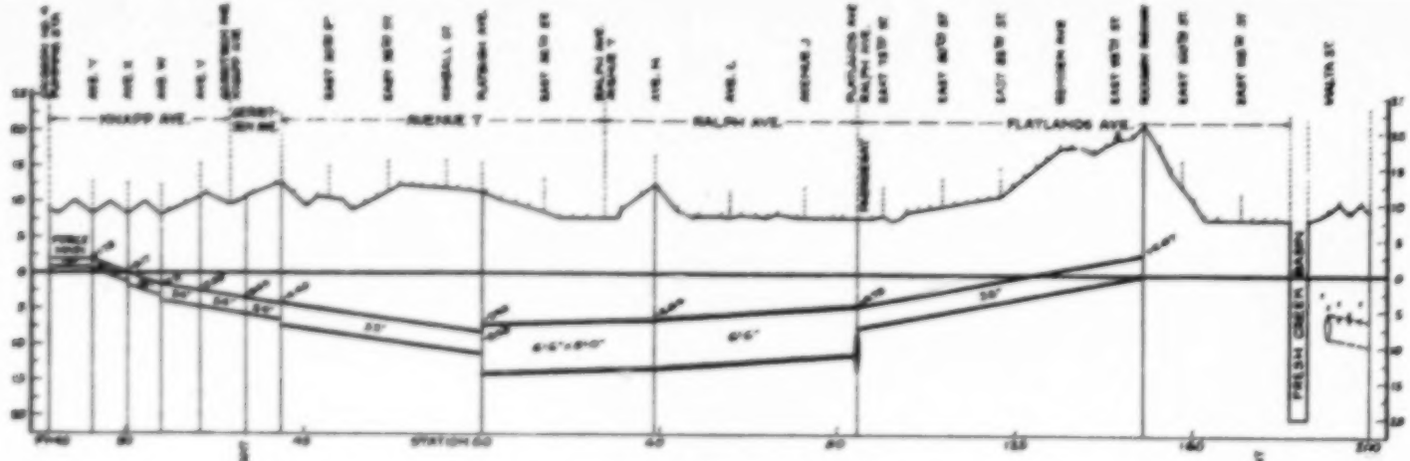
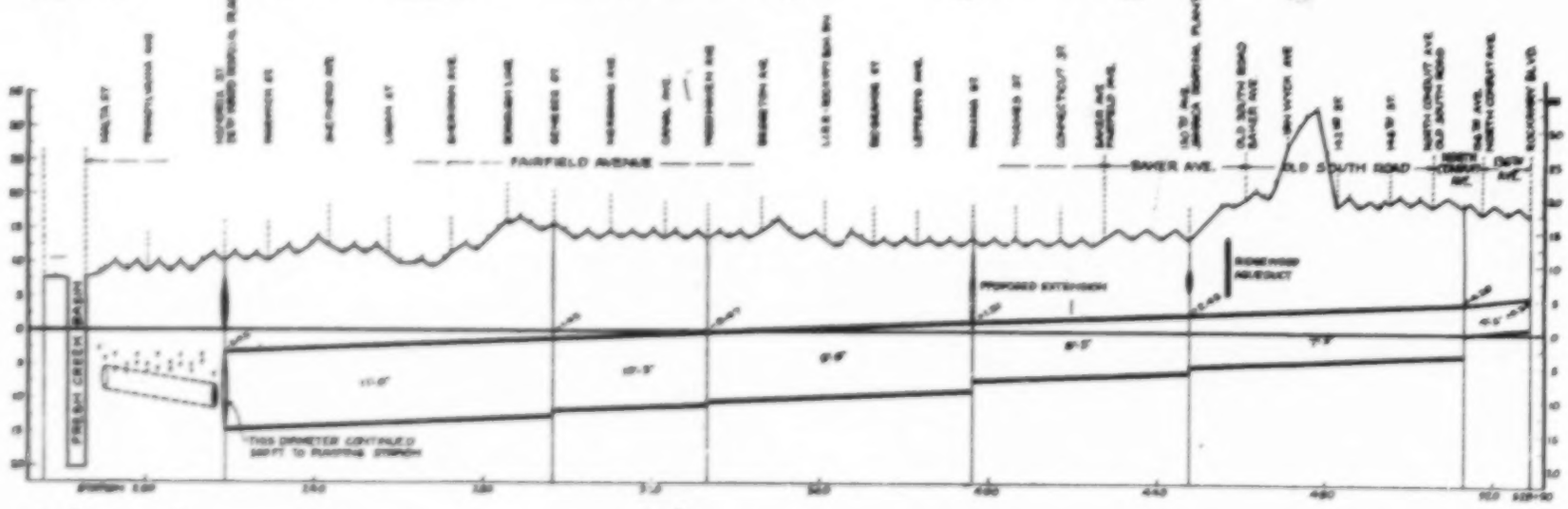
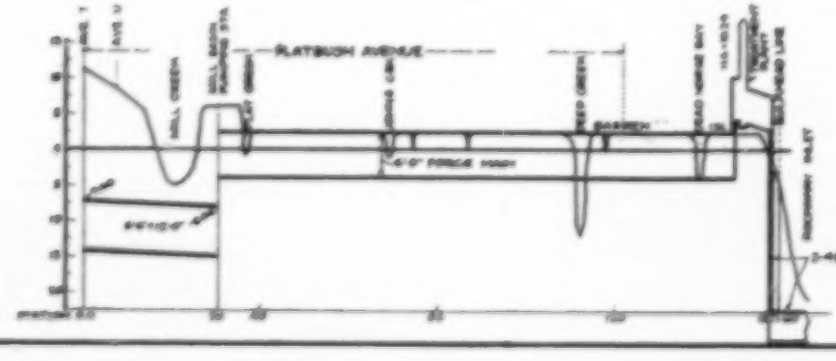


PLATE XVI
NEW JERSEY
MANHATTAN
EAST RIVER
FLUSHING BAY
BOROUGH OF QUEENS
NASSAU COUNTY
BOROUGH OF BROOKLYN
UPPER BAY
RICHMOND
THE NARROWS
CONEY ISLAND
ROCKAWAY INLET
LOWER BAY
ATLANTIC OCEAN
SKETCH SHOWING
SUGGESTED LINES OF MAIN DRAINAGE
FOR TERRITORY ADJACENT TO
JAMAICA BAY
PROJECT D
SCALE OF MILES
FEBRUARY 2, 1937
New York vs New Jersey
Compl. Exhibit No. 869
James D. Maher
Commissioner
Plate XVI

PLATE XVII







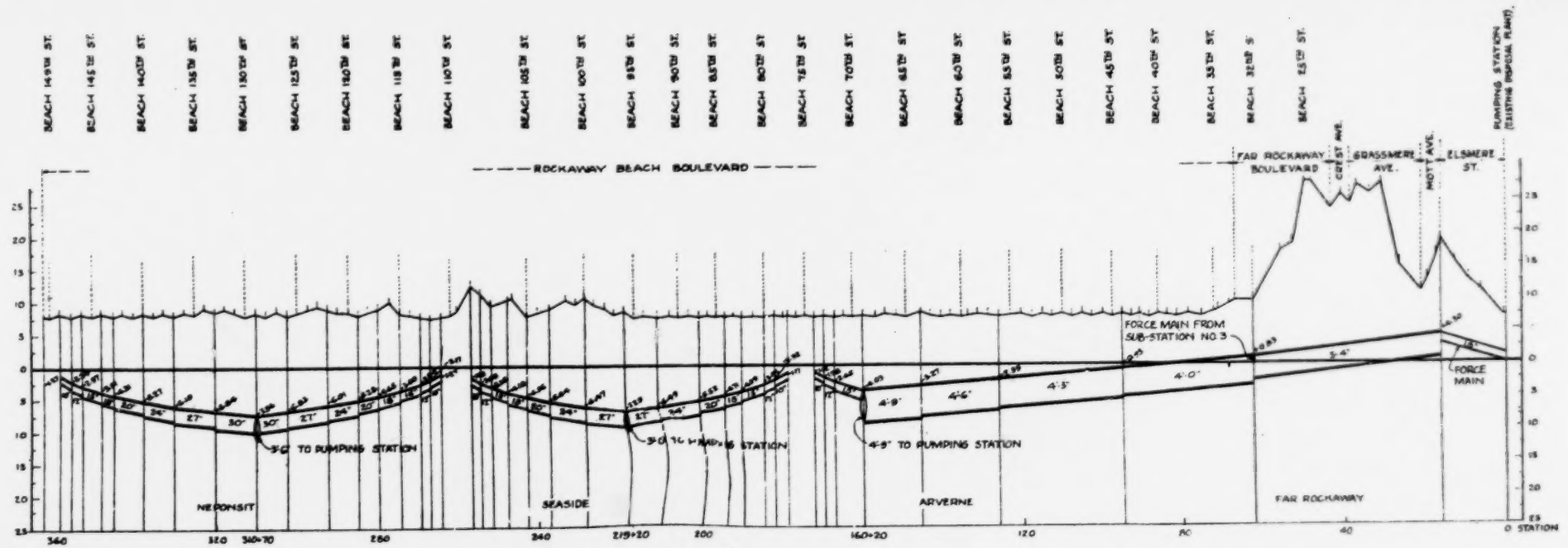
New York v New Jersey
Compl.Exhibit No. 249
James D. Maher
Commissioner
Chart XVII

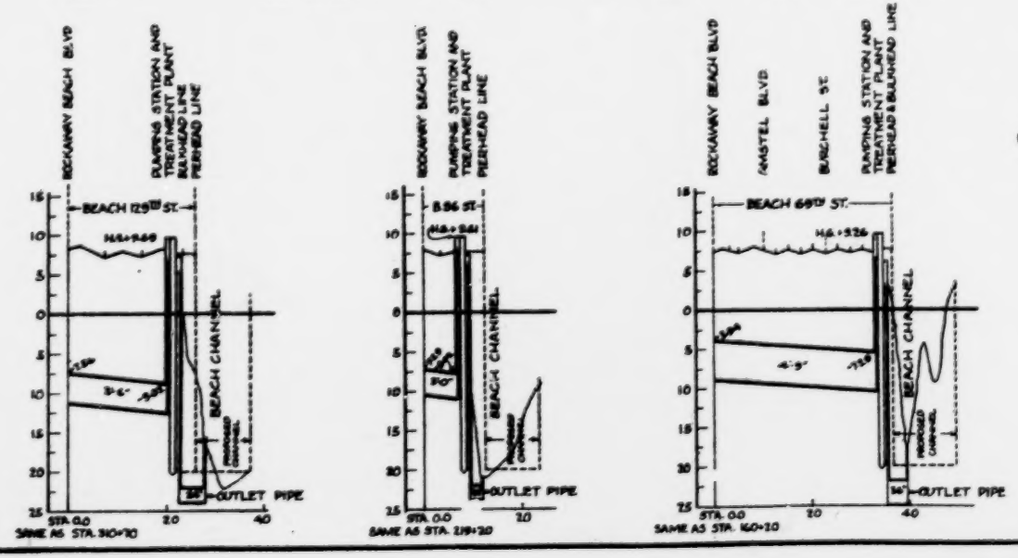
CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

PROFILE OF PROPOSED INTERCEPTORS
LYING
NORTH OF JAMAICA BAY
PROJECT D
JANUARY 1917

DATUM - MEAN SEA LEVEL AT SANDY HOOK
SCALES

PLATE XVIII





COMPLAINANTS EXHIBIT NO. 249

CHART XVIII

Kenneth Allen
ENGINEER OF SEWAGE DISPOSAL
Feb. 4 1917

CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

PROFILE OF PROPOSED INTERCEPTORS
LYING
SOUTH OF JAMAICA BAY
PROJECT D

FEBRUARY 1917

DATUM - MEAN SEA LEVEL AT SANDY HOOK

SCALES

VERTICAL 0 10 20 30 33 FEET

HORIZONTAL 0 1000 2000 3000 4000 5000 6000 FEET

MAP

TOO

LARGE

FOR

FILMING

By Dr. O'Sullivan:

Q. The sewage from Jamaica Bay moves into the Atlantic Ocean, does it?

A. Yes, on the flood current, of course, everything is coming in the Inlet towards the Bay. In the ebb current, experiments made by the War Department show that the current normally turns this point.

Q. Turns what point?

A. Turns Rockaway Point, and flows in a southeasterly direction.

Q. And of all the waters that enter the Atlantic Ocean from the Upper and Lower Bays of New York, and from Jamaica Bay, what percentage of that water returns on flood tides?

Mr. Riker: The question is objected to on the ground that the witness says that none of the water from Jamaica Bay returns from Jamaica Bay.

793 The Commissioner: Note the objection of counsel for the defendants.

(Question repeated, with the addition of the words "into the Upper Bay of New York.")

Mr. Riker: The objection is renewed.

The Commissioner: Note the renewal of the objection of counsel for the defendants.

A. That is shown on the previous exhibit. I do not have it in my mind.

Q. State approximately how much?

A. Practically none of the sewage from Jamaica Bay would return to the Upper Bay. I do not remember what percentage of that coming down to the Narrows returns.

Q. In entering the Atlantic Ocean from the Upper Bay of New York, and by the time it reaches the Atlantic Ocean, how near would the sewage going out on the ebb tide from the Upper Bay of New York come to the Rockaway Inlet?

A. Well, according to my best judgment it would be at least three or four miles under ordinary conditions. With a strong wind blowing from the South, it would approach more nearly the Rockaway shore.

Q. With respect to the four projects that you just mentioned in describing the last exhibit, Complainants' Exhibit 249, were maps prepared showing these four projects?

A. Yes. These four projects are shown on these maps
794 (indicating). The third one of these, Project C, is the one that was adopted for the Rockaway Peninsula.

Q. They were prepared as alternate methods, were they, for disposal of the sewage in that territomy?

A. Yes; and as to the northern area, Project A was recommended with the provision that east of Jamaica, if the conditions in Rockaway Inlet, after tank treatment, are sufficiently bad in the future, the Jamaica sewage can be cut off and carried according to Project

B to Jo Cos Island, and there be treated by some oxidizing process such as sprinkling filters. In my opinion, the conditions here will arrive at such a point that that will be necessary.

Dr. O'Sullivan: I offer the four projects submitted to the Board of Estimate and Apportionment for the collection and disposal of the sewage of that Jamaica Bay territory, and ask that they be marked Complainants' Exhibit 250.

Mr. Riker: The offer is objected to for the reason that this witness says that the sewage in this district does not in any way affect the waters of the Upper Bay.

The Commissioner: Note the objection of counsel for the defendants.

(The four maps were marked Complainants' Exhibit No. 250.)

(Here follow maps marked page 794a.)

PLATE VII
NEW JERSEY
HUDSON RIVER
MANHATTAN
EAST RIVER
FLUSHING BAY
FLUSHING
BOROUGH OF QUEENS
NASSAU COUNTY
BOROUGH OF BROOKLYN
UPPER BAY
RICHMOND
THE NARROWS
LOWER BAY
ATLANTIC OCEAN
CONEY ISLAND
ROCKAWAY INLET
JAMAICA BAY
New York vs New Jersey
Compl. Exhibit No. 250
James D. Maher
Commissioner
Project "A"
EXISTING JAMAICA DISPOSAL PLANT
EXISTING RED HOOK DISPOSAL PLANT
PUMP STA.
TREATMENT PLANT OUTLETS
SKETCH SHOWING
SUGGESTED LINES OF MAIN DRAINAGE
FOR TERRITORY ADJACENT TO
JAMAICA BAY
PROJECT A
SCALE OF MILES
JANUARY 15, 1917

PLATE X
New York vs New Jersey
Compl. Exhibit No.250
James D. Maher
Commissioner
Project "B"
EAST RIVER
NEW JERSEY
HUDSON RIVER
MANHATTAN
EAST RIVER
FLUSHING BAY
FLUSHING
BOROUGH OF QUEENS
NASSAU COUNTY
BOROUGH OF BROOKLYN
UPPER BAY
RICHMOND
THE NARROWS
CONEY ISLAND
ROCKAWAY INLET
LOWER BAY
ATLANTIC OCEAN
SKETCH SHOWING
SUGGESTED LINES OF
MAIN DRAINAGE
FOR TERRITORY ADJACENT TO
JAMAICA BAY
PROJECT B

PLATE XIII
EAST RIVER
FLUSHING BAY
NEW JERSEY
HUDSON RIVER
MANHATTAN
EAST RIVER
BOROUGH OF QUEENS
NASSAU COUNTY
UPPER BAY
BOROUGH OF BROOKLYN
RICHMOND
THE NARROWS
CONEY ISLAND
ROCKAWAY INLET
LOWER BAY
ATLANTIC OCEAN
JAMAICA BAY
New York vs New Jersey
Compl. Exhibit No.250
James D. Maher
Commissioner
Project "C"
SKETCH SHOWING
SUGGESTED LINES OF
MAIN DRAINAGE
FOR TERRITORY ADJACENT TO
JAMAICA BAY
PROJECT C
SCALE OF MILES

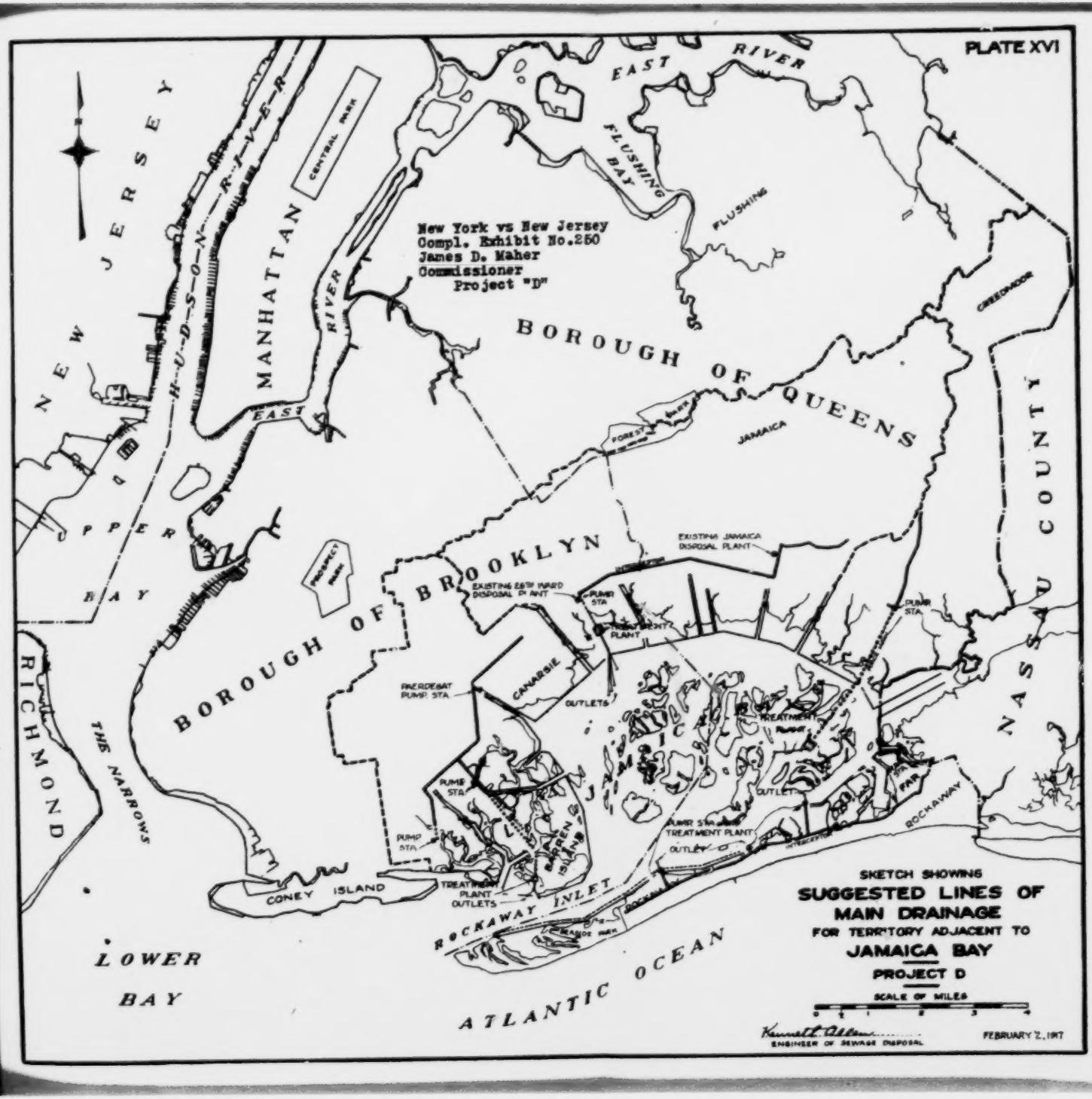
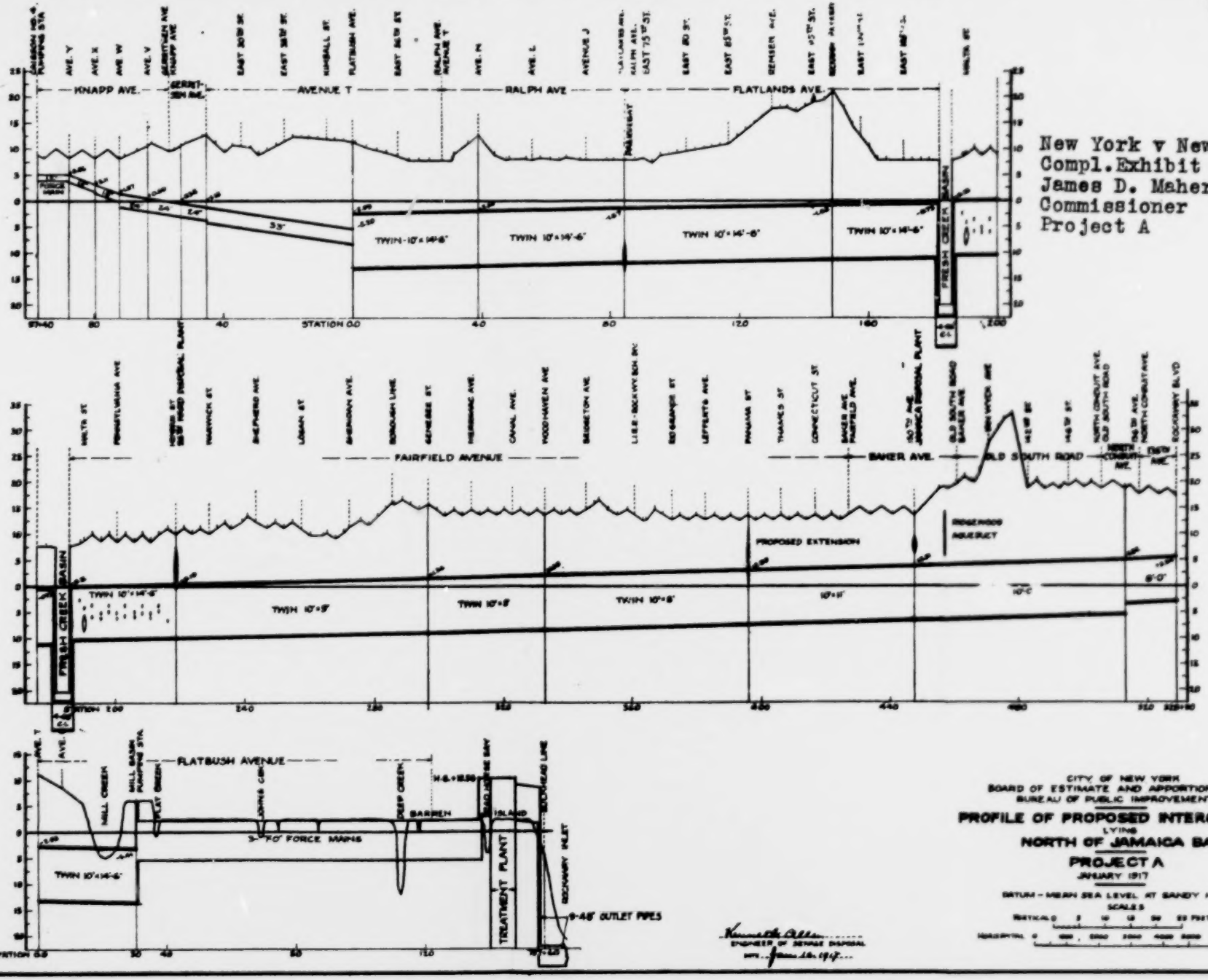


PLATE XVI
New York vs New Jersey
Compl. Exhibit No.250
James D. Maher
Commissioner
Project "D"
EAST RIVER
FLUSHING BAY
FLUSHING
NEW JERSEY
HUDSON RIVER
MANHATTAN
CENTRAL PARK
EAST RIVER
BOROUGH OF QUEENS
CREEDMOOR
JAMAICA
FOREST PARK
NASSAU COUNTY
UPPER BAY
PROSPECT PARK
BOROUGH OF BROOKLYN
EXISTING JAMAICA DISPOSAL PLANT
EXISTING 26TH WARD DISPOSAL PLANT
PUMP STA
TREATMENT PLANT
PUMP STA
RICHMOND
THE NARROWS
PAERDEGAT PUMP STA
CANARSIE
OUTLETS
JAMAICA BAY
TREATMENT PLANT
OUTLET
FAR
ROCKAWAY
PUMP STA
PUMP STA
BARREN ISLAND
PUMP STA TREATMENT PLANT
OUTLET
CONEY ISLAND
TREATMENT PLANT OUTLETS
ROCKAWAY INLET
BEACH PARK
LOWER BAY
ATLANTIC OCEAN
SKETCH SHOWING
SUGGESTED LINES OF
MAIN DRAINAGE
FOR TERRITORY ADJACENT TO
JAMAICA BAY
PROJECT D
SCALE OF MILES
0 ½ 1 2 3 4
ENGINEER OF SEWAGE DISPOSAL
FEBRUARY 2, 1917

PLATE VIII



New York v New Jersey
Compl.Exhibit No.251
James D. Maher
Commissioner
Project A

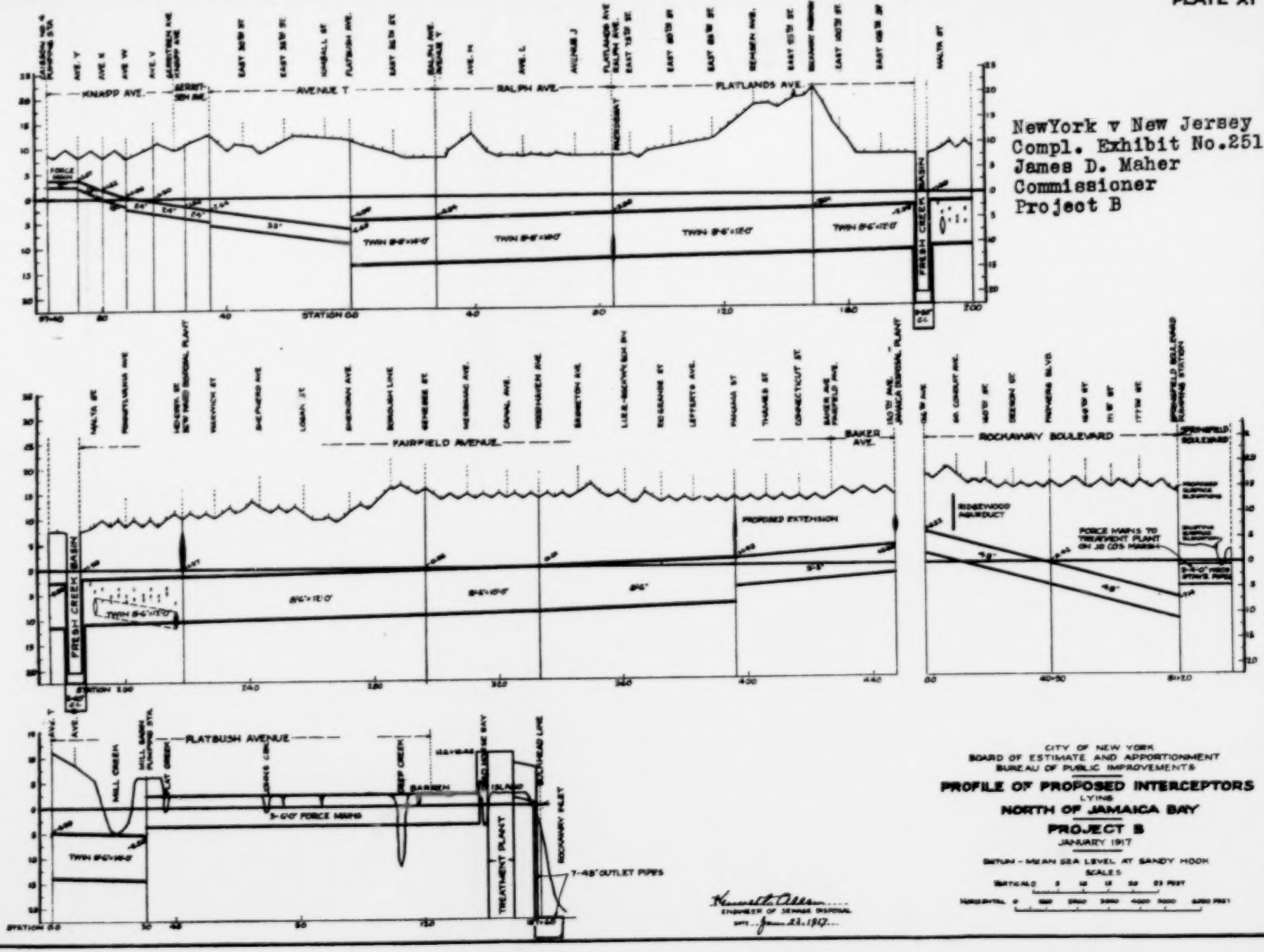
CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

PROFILE OF PROPOSED INTERCEPTORS
LYING
NORTH OF JAMAICA BAY
PROJECT A
JANUARY 1917

DATUM - MEAN SEA LEVEL AT SANDY HOOK
SCALES

Kenneth Allen
ENGINEER OF SEWAGE DISPOSAL
NEW YORK, January 10, 1917

PLATE XI



NewYork v New Jersey
Compl. Exhibit No.251
James D. Maher
Commissioner
Project B

CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

PROFILE OF PROPOSED INTERCEPTORS

LYING

NORTH OF JAMAICA BAY

PROJECT B

JANUARY 1917

DATUM - MEAN SEA LEVEL AT SANDY HOOK

SCALES

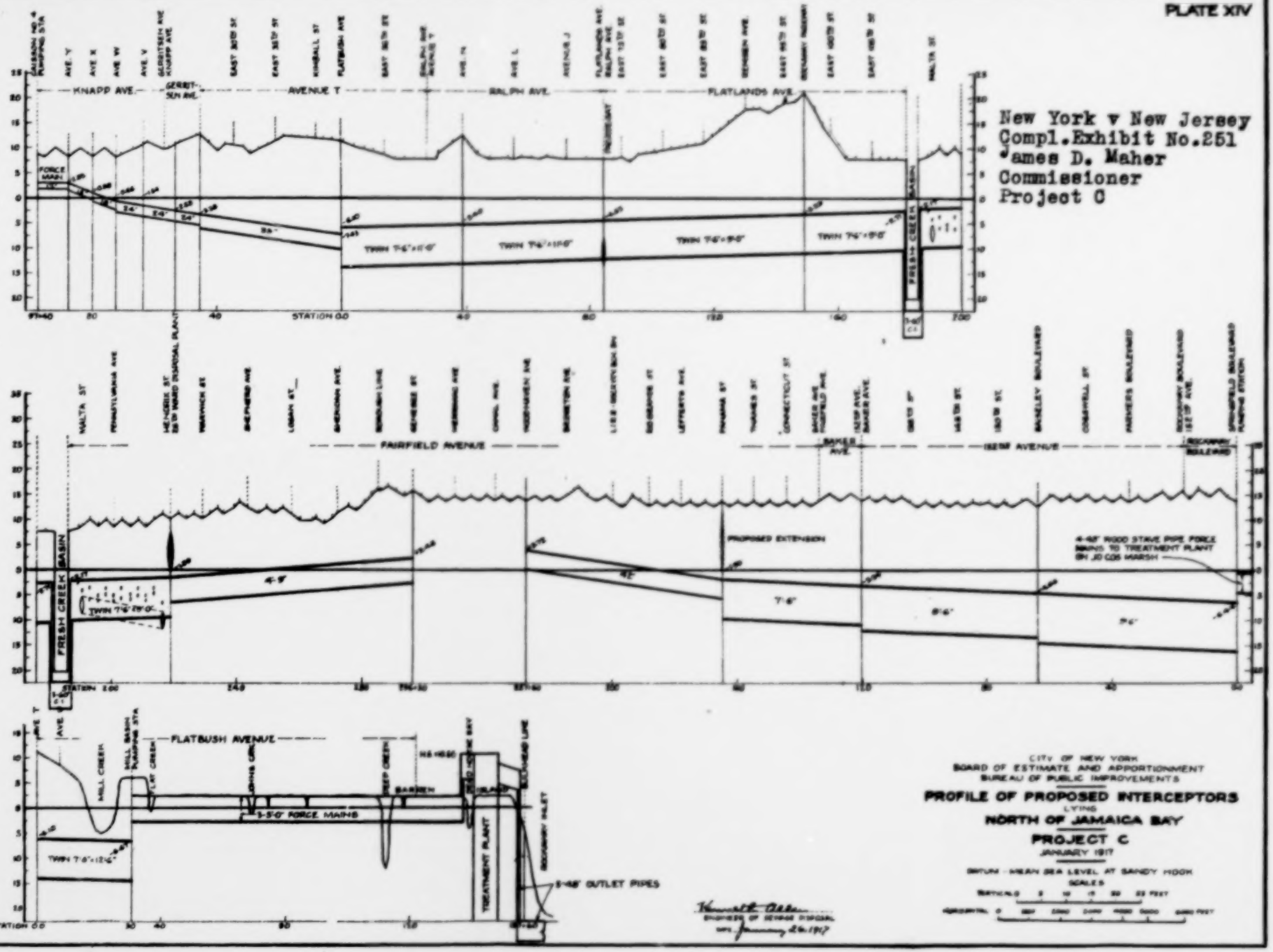
VERTICAL 0 5 10 15 20 25 FEET

HORIZONTAL 0 1000 2000 3000 4000 5000 6000 FEET

Kenneth Allen
ENGINEER OF SEWAGE DISPOSAL
DATE January 23, 1917

PLATE XIV

New York v New Jersey
Compl.Exhibit No.251
James D. Maher
Commissioner
Project C



CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

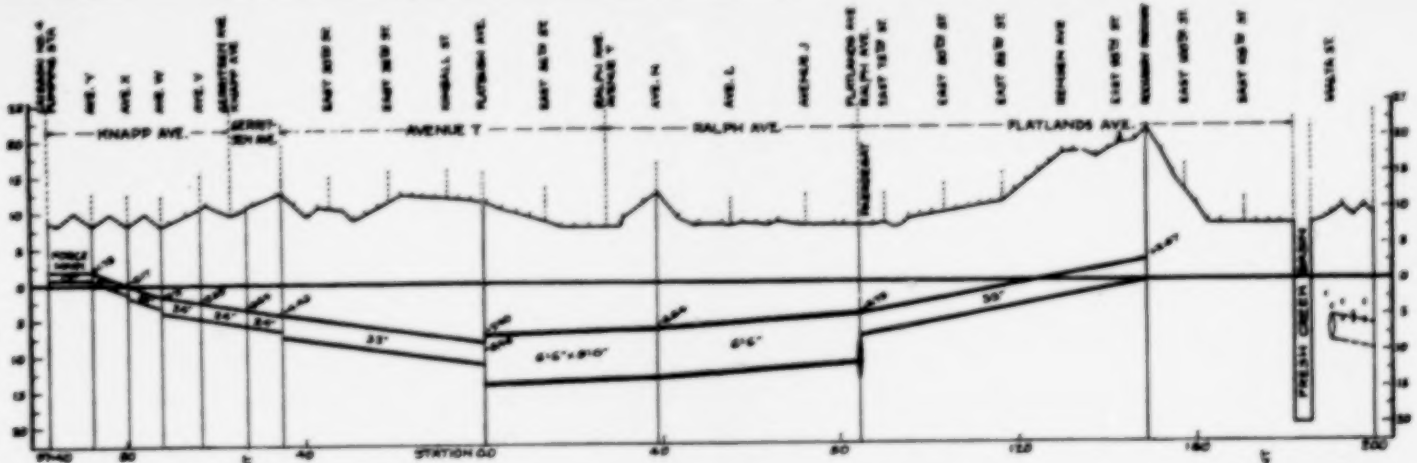
PROFILE OF PROPOSED INTERCEPTORS
LYING
NORTH OF JAMAICA BAY
PROJECT C
JANUARY 1917

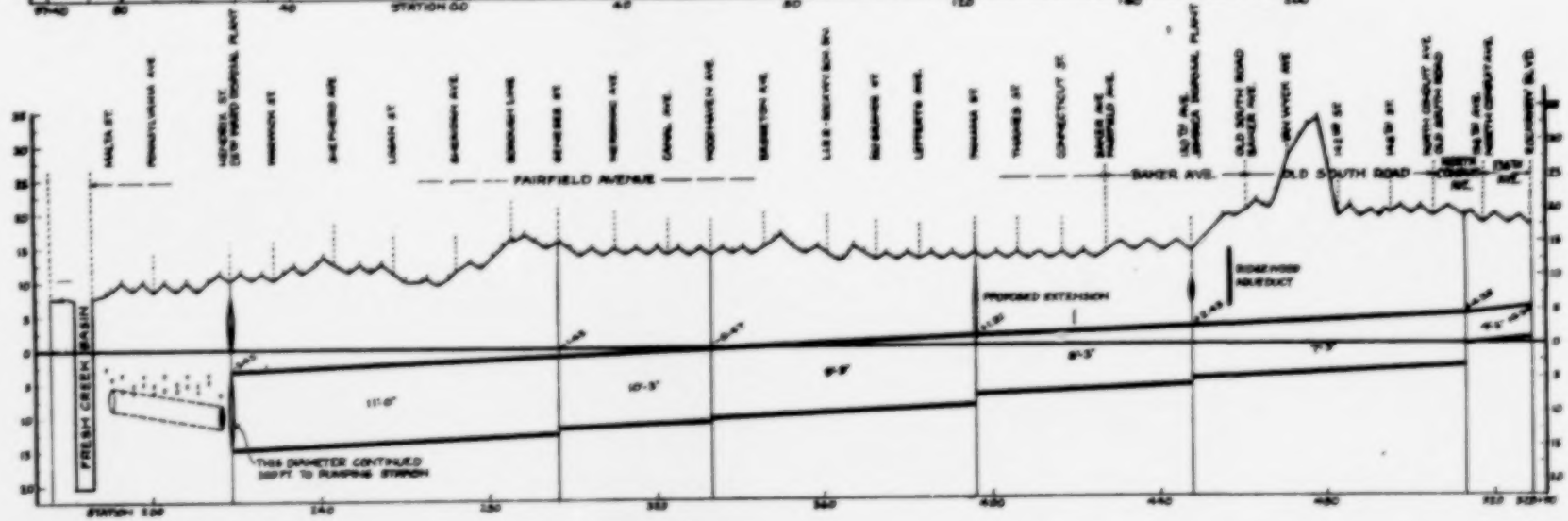
DATUM - MEAN SEA LEVEL AT SANDY HOOK
SCALES

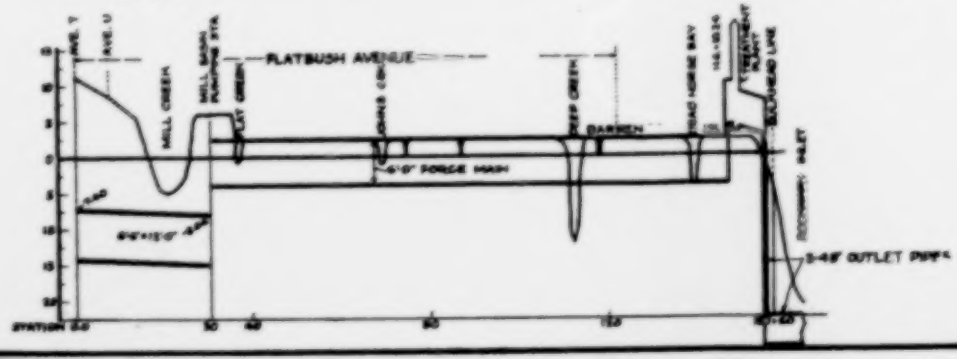
ENGINEER OF SEWAGE DISPOSAL
DATE January 26, 1917

PLATE XVII

New York v New Jersey
Compl.Exhibit No. 251
James D. Maher
Commissioner
Project D







CITY OF NEW YORK
BOARD OF ESTIMATE AND APPORTIONMENT
BUREAU OF PUBLIC IMPROVEMENTS

PROFILE OF PROPOSED INTERCEPTORS
LYING
NORTH OF JAMAICA BAY
PROJECT D
JANUARY 1917

DATUM - MEAN SEA LEVEL AT SANDY HOOK
SCALES

Q. Were designs completed and submitted for proposed interceptors to the north of Jamaica Bay relative to these projects?
A. They were and are shown on these four prints. (Indicating.)

795 Dr. O'Sullivan: I offer the four plans or designs for intercepters for the north of Jamaica Bay, dated January, 1917, and ask that they be marked as Complainants' Exhibit No. 251.

By Mr. Riker:

Q. Mr. Allen, the sewage which it is designed to intercept by the work shown on these plans now discharges into Jamaica Bay?
A. Yes.
Q. And will discharge into Jamaica Bay when treated by these treatment works and intercepters?
A. They will discharge at the entrance to Jamaica Bay, or just above the entrance.
Q. That sewage now, and after these works are put in operation, when they are built, does not reach the Upper Bay, does it?
A. No.

Mr. Riker: Same objection to this offer as to the last.
The Commissioner: Note the objection of counsel for the defendants.

(The four papers were marked Complainants' Exhibit No. 251.)

(Here follow diagrams marked page 795a.)

By Dr. O'Sullivan:

Q. In addition to the plans that have already been marked as exhibits for the collection and disposal of the sewage of Jamaica Bay, have you prepared other plans for the collection and disposal of sewage tributary to Jamaica Bay?

A. Yes, I have a plan here which shows the combination of the two projects, that were recommended. This one for the south
796 side and this one for the north side. The dotted portion shows the tentative intercepters and collectors that may be altered in case the water should prove to be overloaded at this point (indicating). In that case, from this point to the sea, the sewage would collect from this point to this (indicating); and these would remain as they are, being carried down to this island here (indicating), where there would be a sprinkling filter plant, or some other oxidizing plant.

Dr. O'Sullivan: I offer that map and ask that it be marked Complainants' Exhibit No. 252.

Mr. Riker: Same objection as to the last offer.

The Commissioner: Note the objection of counsel for the defendants.

(The paper was marked Complainants' Exhibit 252).

(Here follows map marked page 796a.)

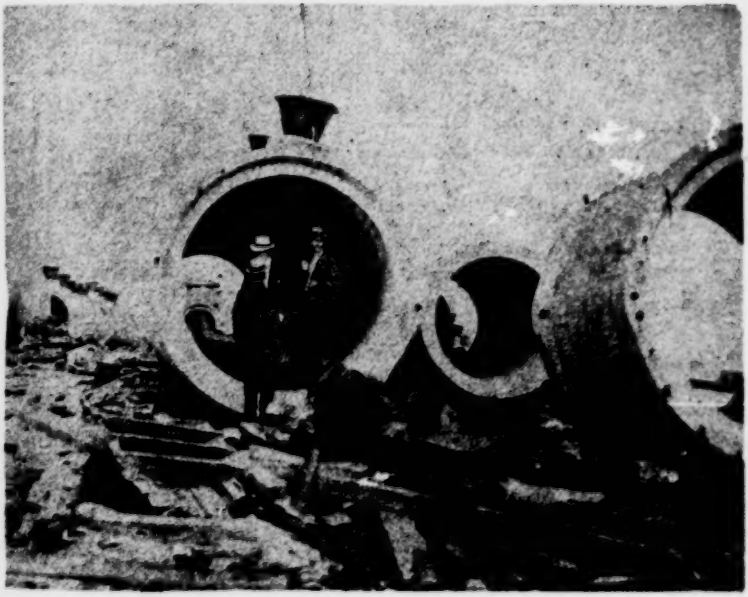
MAP

TOO

LARGE

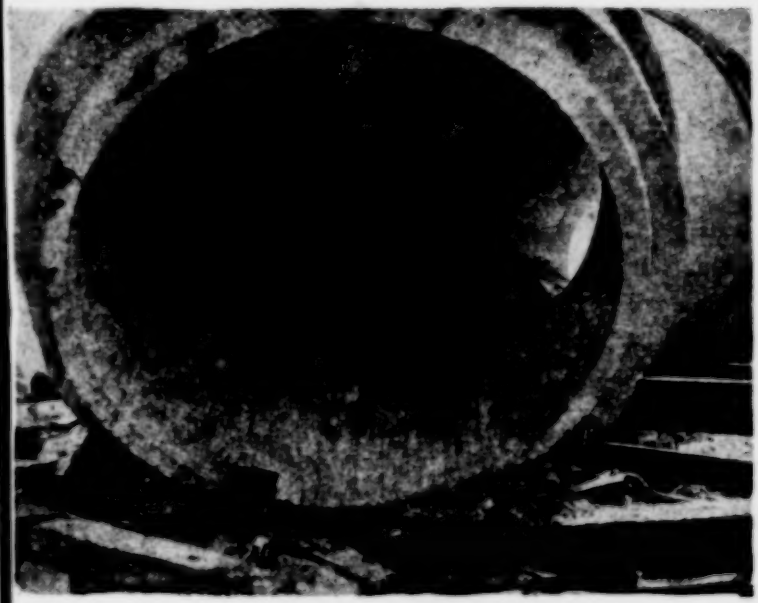
FOR

FILMING



New York vs New Jersey
Compl. Exhibit No.253
James D. Maher
Commissioner
Sheet A

New York vs New Jersey
Compl. Exhibit No.253
James D. Maher
Commissioner
Sheet B



New York vs New Jersey
Compl. Exhibit No.253
James D. Maher
Commissioner
Sheet C

Q. Did you examine the plant of the Passaic Valley Sewerage Commission at any time within this year?

A. I did a few days ago.

Q. Did you pay any particular attention to the diffusion nozzles that have been previously described at these hearings?

A. Yes.

Q. Did you make photographs of them?

A. Yes.

Q. Have you got them?

A. I have here three views, two of which show those nozzles before they are enclosed in concrete. The concrete I understand is to be extended from the top of the neck of the concrete ex-
797 tending above the concrete sewer to the top of the cast iron nozzle. Two of these are views containing the nozzle, and the third one is a view of a section of the outlet sewer on a bend.

Dr. O'Sullivan: I offer these photographs in evidence and ask that they be marked Complainants' Exhibit No. 253.

By Mr. Riker:

Q. You took these photographs last Thursday, did you not?

A. I think it was Thursday.

Q. You were given every opportunity to examine the works?

A. Yes.

Q. And did the Engineer in charge of the works at that time, give you permission to take these photographs?

A. He did. I asked his permission.

Q. Who accompanied you on the expedition?

A. The Chief Engineer, Mr. Brown, and Mr. Taylor, his assistant; Prof. Landreth; Dr. O'Sullivan; Prof. Phelps and Mr. Van Duyne. I think those are the only ones I remember.

Q. Some of these gentlemen are shown in one of these photographs?

A. Yes.

(The three photographs were marked Complainants' Exhibit No. 253.)

(Here follows photographs marked page 797*a*.)

By Dr. O'Sullivan:

Q. Mr. Allen, will you describe the dispersion nozzles.

A. The nozzles are made of cast iron. They are 28 inches
798 in diameter on top, and inside there is a spiral passageway, that ends with a circular plate on top, which is 24 inches in diameter, permitting the sewage to discharge in an annular ring two inches thick and 28 inches diameter outside. Those nozzles are 272 inches long. The sewage, as it passes through the nozzle, is supposed to be given a spiral motion, which mixing with the water inside and outside the cone, provides a rapid diffusion of the sewage.

Q. What is the approximate weight of these sections here of the diffusion nozzles?

A. Mr. Brown mentioned one section 50 feet long that weighed 50 tons. I am not sure whether that was the largest size or not, but it was a large size.

Q. Were you in the screen house?

A. I was, and I saw the provision for the screens, but the screens had not been installed. I was told by Mr. Taylor that they were to be of the cage type similar to those at Nut Island. Those screens are understood to be ¾-inch rods, spaced an inch and a half apart, and with two rolls staggered, so that the clear space in passing through at right angles to the side of the screen would be one-eighth of an inch; but if passing through between the bars, the space would be between ¾ of an inch and 1½ inches. I have here some figures of the amount of screenings removed by the Nut Island screen
Chamber in 1918. The average removal was 5/100 of a
799 cubic yard per million gallons; while the Hamburg screen, which is a different type, in which the bars are .6 of an inch apart, removed .34 of a cubic yard per million gallons, or seven times as much as the Nut Island.

Q. Will you compare these various types of screens as used at Hamburg, at Nut Island, and the Riensch-Wuri screen that you have installed at the Dyckman Street plant, with the screening device as described to you by the engineers of the Passaic Valley Sewerage Commission at the plant on the Newark Meadows?

A. So far as I understand, the plant on the Newark Meadows is to be practically the same as that at Nut Island, the same sized rod and ⅛ of an inch clear space at right angles to the side of the screen. At Nut Island the clear space between the rods in the same row is 1½ inches, and the size of the bar is the same. The Riensch-Wuri screen is quite different in design. That is made of a brass plate with slots, varying usually from ⅛ to 1/16 of an inch in width, and about two inches long, placed close together. The form of the screen is something like that of a hat with a wide flat rim and a conical crown. The rim is perforated as described, and in all the sizes over about 10 feet diameter, the crown is also perforated. It is set on an inclined shaft and rotated slowly in the sewage, filling the entire channel, so that practically nothing can be by-passed. The motion

is slow and the velocity in passing the screen, if properly de-
600 signed, is also slow, so that comparatively a large percentage of the solid matter is removed.

Q. How are these screens cleaned?

A. The screens are cleaned by two sets of brushes, one of which rotates on radial arms and cleans the flat plate, brushing the contents through an aperture on to a belt conveyor, or into a can. The other set of brushes operates on the face of the cone, brushing the material down on to the flat plate from which it is removed as described.

Q. Are these operated mechanically or by hand?

A. These are operated mechanically. Those at Dyckman Street make about one revolution in two minutes.

Q. What advantage has a mechanically-operated brush over a hand-operated brush in cleaning the material from screens?

A. In a mechanically-operated screen nothing is left to the workman who may be careless in his job, and the work goes on without interruption, at a minimum of cost. There are cases where coarse screens are more economically operated by hand; but if the screening is to be fine screening, this is rarely the case. By fine screening, as defined by the Committee on Sewerage and Sewage Disposal of the American Public Health Association, is meant screens of less than ⅛ of an inch opening. A third type of screen that I am to describe is the Hamburg type, in which a series of links are
601 arranged side by side, with a certain spacing, forming an endless band which passes over a shaft at the top, and one at the bottom, at an inclination to the horizontal. The screenings are carried upon the upper side with a slow motion, and after passing the top, are removed by a series of automatically operated prongs which are inserted and withdrawn, leaving the screenings to drop on a belt conveyor. The links at Hamburg are spaced 15 millimeters apart in the old plant, which serves the larger part of the City; and 10 millimeters apart in the newer plant serving a manufacturing district on the south side of the Elbe River.

Q. Mr. Allen, in relation to some of the exhibits that have already been marked in evidence, dealing with the oxygen contained in the harbor waters of New York at its various areas, have these facts been broadly published in the American Journal of Public Health?

A. Yes.

Q. And in the Municipal and County Engineering Journal?

A. Yes.

Q. And in the Engineering News Record, an Engineering Journal?

A. Yes.

Q. And at different dates?

Mr. Riker: We object to the question as immaterial and irrelevant.

The Commissioner: Note the objection of counsel for the defendants

602 A. Yes.

Q. Beginning in 1918?
A. Yes.

Dr. O'Sullivan: He is your witness, Mr. Riker.

Cross-examination.

By Mr. Riker:

Q. Mr. Allen, how many sets of screens did you find provision made for in the Passaic Valley disposal plant?
A. I think there were four; there may have been six.
Q. What types of screens were they?
A. They were the cage type.
Q. Was there any difference in the size of the apertures in these screens?
A. Not that I know of.
Q. Your attention was not directed to the fact that there were rough screens and fine screens?
A. No.
Q. Do you know whether, as a matter of fact, they are provided for?
A. I asked what the size of the aperture was and I was told.
Q. They gave you only one aperture?
A. Yes.
Q. Who did that?
A. The Assistant Engineer.
Q. Mr. Taylor?
A. Mr. Taylor, yes, sir.
Q. Outside of that statement of Mr. Taylor, don't you know that there were two types of screens to be installed in that plant, one coarse and the other fine?
A. No.
Q. You don't know that?
A. No.

803 Q. In your opinion, is the Reisch-Wurl screen superior in efficiency to the screen that is designed as you understand it to be installed there?
A. Greatly inferior. I do not consider them in the same class.
Q. Did you say "greatly inferior"?
A. Yes.

Mr. McCarter: He does not understand your question.
Mr. Riker: Will you repeat my question.
(Question repeated as follows:)

"Q. In your opinion, is the Reisch-Wurl screen superior in efficiency to the screen that is designed as you understand it to be installed there?"

A. Greatly superior.
Q. It is a patented screen, is it not?
A. Yes.

Q. Do you know who controls the patent here?
A. The Sanitation Corporation.
Q. Is that a New York Corporation?
A. I think it is. I am not sure of that.
Q. Do you know who the personnel of that corporation may be?
A. Mr. D-Olier is the active man. I do not know whether he is personally interested or not.
Q. Your opinion is then, that the introduction of this type of screen in the Passaic Valley Sewerage Commissioners' works will add to the efficiency of the works as planned?
A. I do not know that.
Q. I ask you whether it is your opinion that it will?
A. It would add to the efficiency in the removal of the material before entering the basins. I should say that it would add to the efficiency of the plant.
Q. Is the Hamburg screen a patented screen?
A. That I cannot say, but I think it is.
Q. Is the Nut Island screen a patented screen?
A. Not that I know of.
Q. What do you term the Nut Island screen, rough or fine screen?
A. A course screen.
Q. And do you know in operation what it is designed to remove?
A. Yes.
Q. What?
A. Course material.
Q. And that is all?
A. Yes.
Q. What is the population at this date contributing sewage to the waters of Upper New York Bay?
A. I would have to refer to my exhibits to tell you.
Q. Well, refer to it and tell us.
A. (Referring to exhibit:) 788,000 contributing directly to the Bay.
Q. 788,000?
A. Yes.
Q. 788,000 contributing directly to the sewage?
A. To the New York Upper Bay from New York City.
Q. What population of the City of New York is discharging into the waters of New York Bay, directly and indirectly?
A. I will have to add that up. 5,797,000.
Q. What localities do you include in that computation?
A. The sewage that enters the Hudson; the sewage that enters the Harlem; the sewage that enters the Upper East River; the sewage that enters the Lower East Bay; the sewage that enters directly the Upper Bay; the sewage that enters the Kill van Kull.
Q. That is sewage from the Greater City of New York?
A. Yes.
Q. How much do you estimate the sewage so discharged, in gallons?
A. 675,000,000 gallons a day.

Q. And that is a per capita discharge of how much?

A. About 118 gallons per capita.

Q. In fixing on the amount of discharge of sewage into the waters of the Upper New York Bay directly and indirectly from population, did you make the computations?

A. I am not sure whether I made them all or not. I made part of them. No, I did not make all. I made part.

Q. You have never actually measured the sewage discharging into New York Bay, have you?

A. No, sir.

Q. It is an estimate on an estimated per capita discharge, is it not?

A. It is estimated. The estimate is based on the water consumption.

Q. On the water consumption?

A. Yes, sir.

Q. And that is divided up into a per capita water consumption, isn't it?

A. Yes.

Q. And then that is the basis of the per capita sewage
806 discharge?

A. Yes.

Q. How is it that you had to compute it? Didn't you know what it was?

A. How is what?

Q. How is that you had to compute the per capita discharge?

A. Because I wanted to arrive at the results.

Q. Are you sure that that result is correct, and that is the per capita discharge that is used for the determination of the total discharge in the waters of New York Bay?

A. I am sure it is substantially correct.

Q. Isn't it 120 gallons per capita?

A. It might be 120.

Q. Through how many sewer outlets does this sewage discharge into New York Bay, directly and indirectly?

A. I will have to refer to my notes. I have not that figure here.

Q. Is it 445? Do you happen to remember whether that is correct?

A. I should think it was that.

Q. Without having the figures of the exhibit before you, you are unable to state from memory how many there are?

A. I should say it was about that.

Q. How many of these sewer outlets are at the foot of slips?

A. I cannot say that. I have given the number that have been extended to the pierhead in Manhattan. Outside of Manhattan, very few have, and the others either discharge in the slips or else
807 at the bulkhead line. For instance, along the Harlem River where there are no slips, the discharge has been right at the bulkhead line.

Q. It has been part of the duty delegated to you, to provide plans for the disposal of the sewage in New York City, which is not objectionable, by new methods, has it not?

A. Yes.

Q. Have you made a study of the existing sewage discharge?

A. I have.

Q. And you do not know how many sewers are discharging into the slips?

A. I have never counted them, no.

Q. You do know, however, as given in a report, the number discharging at the pierhead line?

A. Yes.

Q. Are those sewer outlets at the surface or below the surface of the water?

A. Those are, many of them, submerged at high water. The general rule seems to have been to place the invert at mean low water, but this is not strictly adhered to.

Q. Now have you made some inspection of the waters of New York City, as you have testified. When did you make your last inspection?

A. I do not know when it was.

Q. Within a year?

A. I am frequently around the harbor, and I always take note of the water, but I do not believe I have made an official inspection within a year, no.

Q. Within two years?

A. Not a general inspection of the whole harbor. Within a year I have gone to certain points to observe the conditions; but
808 I have not made a general inspection covering the entire harbor, as an independent piece of day's work, for several years. I have been out frequently with a party collecting samples, and I have been frequently on the river in other ways, and have always noted the condition of the water. I have lived up on Riverside Drive, where I could see the condition at that point; but a special trip and inspection, I do not recall now having been made within the last year.

Q. Or the last two years?

A. I would not say.

Q. When you undertook to describe conditions as they appeared to you on an inspection of the waters of New York Bay, did you have in mind any particular inspection?

A. Most of those notes were made in 1913.

Q. In 1913?

A. Yes.

Q. And at the time those notes were made, Mr. Allen, you found objectionable conditions to exist in certain parts of the waters of the harbor of New York?

A. Yes.

Q. Where did you find the most objectionable conditions to exist?

A. The most objectionable to sight were in the Lower East River, but the nearest approach to offensive conditions from odors and so on, was in the Harlem River.

Q. What about Newtown Creek?

A. Well, I was speaking of the main bodies of water. Newtown Creek and Gowanus Canal are or were in very bad condition.

Q. What did you observe as to the condition of the waters
809 of the Hudson along Manhattan Island?

A. The waters of the Hudson, as regards sewage pollution, are in fairly good condition, most of the year; but there are local nuisances along the shores. There is no immediate apprehension of a general nuisance in the Hudson.

Q. In preparing the plans for collection and disposal of sewage in the Greater City of New York, speaking generally, what plan do you recommend for the Manhattan Island Hudson River front?

A. Speaking generally, I believe that fine screens, with a suitable submerged outlet will answer every purpose, with the one exception that it is possible in the far future that if this sewage from the Bronx is brought to the West 155th Street point, something more refined will be needed at that point.

Q. That plan which you speak of for the 155th Street outlet involves how much sewage?

A. As estimated in 1915, 110,000,000 gallons a day.

Q. That is an estimate for the year 1960?

A. Yes, for that year.

Q. And when you testified that you did not apprehend any objectionable conditions as likely to occur on the Hudson River front in Manhattan Island, did you refer to the year 1960?

A. Yes.

Q. Why do you specify submerged outlets?

A. Because that is a much better way of disposing of it
810 than discharging at the surface. That is shown very clearly in connection with the Boston outlet, as I think Mr. Stearns testified.

Q. And the outlets that you have designed, are they placed close to the shore, or are they in the stream?

A. They are usually placed at least 100 feet from the shore. Not in all cases, however. There are exceptional cases, where the water is very deep close to the pierhead line, and there they are not taken out so far.

Q. Now, as to this sewage that under this plan is to be discharged into the Hudson River direct, Borough of Manhattan, does any plan that you have submitted, involve the taking of that out to the island near Coney Island?

A. No.

Q. That is, the plan involves no change in the disposal of that sewage?

A. No.

Q. The sewage that is now discharged, and the larger amount that is planned to be discharged, through the Bronx Valley sewer, Mr. Allen, are you contemplating in your plans any change in the disposition of that sewage?

A. You say the Bronx Valley sewer? You do not mean the Bronx Valley sewer, do you?

Q. Yes, I do.

A. That is outside of New York.

Q. Yes, it is outside of New York.

A. That is something that is not in my province. I know nothing about it.

Q. You do not plan any change in that at all? A. We have no authority to make the change in that.

811 Q. Is that outside of the City of New York?

A. Yes.

Q. No parts of that sewer system serve the Borough of the Bronx?

A. No; there is a very small area in the Borough of the Bronx that it is possible may be pumped over into the Bronx Valley Sewer, but it is a very small and insignificant amount.

Q. Being outside of your province, you have not contemplated, naturally, any change in that outlet?

A. No.

Q. Have you any knowledge of that sewer?

A. Oh, yes.

Q. Is that sewage as discharged, stale or septic or fresh sewage?

A. When I saw it, the amount was quite small, and I did not observe any offensive conditions. The length of the sewer, though, is such that I would anticipate it would be septic.

Q. What is the length of it?

A. As a guess I should say it was about 15 miles long.

Q. Now the sewage which is at present discharging into the Harlem River, you have planned to divert that or to treat it?

A. Yes.

Q. Which have you planned to do?

A. Both.

Q. Is that sewage to be discharged, under any of the plans, at the made or artificial island off Coney Island?

A. No, it is contemplated to carry none of the Harlem River Sewage to the Outlet Island.

Q. Is that also true of the waters of the East River, of

812 the Upper East River?

A. That is also true of the waters of the Upper East River.

Q. In like manner, it is not contemplated to carry any of the sewage which I have referred to, as contemplated to be taken to the artificial island, to Red Hook?

A. No.

Q. It is not contemplated to discharge it there?

A. No.

Q. What proportion of the total sewage of the Greater City of New York is planned to be carried out to the island which it is contemplated to be constructed off Coney Island?

A. It is planned to take 200,000,000 gallons, and the total in 1960 is 1,789,000,000, so that would be a little more than one-ninth.

Q. And are the works as planned and submitted by you, designed to accommodate the 200,000,000 from the beginning?

A. Not all. The tunnels would probably have to be made full size; but if any island and treatment plant were constructed, those could be made progressively.

Q. What is the estimated amount of sewage which it is planned

to divert at the present time and discharge either at the island off Red Hook or the island off Coney Island?

A. The plan of the Metropolitan Commission was to take 200,000,000 gallons at the outset. My own impression is now that they would hardly be likely to take the Manhattan sewage to that point, and if not, if they took the 200,000,000 gallons from Brooklyn, they might not get the entire 200,000,000 gallons at the
813 start; but they would get a good part of it by extending the intercepters up to the Queens line. It was not contemplated in the original Metropolitan plan carrying it that far, but the idea is to carry it as near the 200,000,000 as passible, at the start.

Q. What treatment is contemplated at the Red Hook Island?

A. Well, that was discussed somewhat in my discussion of the Miles process, and the activated sludge process. Nothing has been decided as to that, because the whole thing depends very largely on the disposal of the Passaic Valley sewage.

Q. You have submitted some plans for treatment, have you not, Mr. Allen?

A. No, I can not say that I have submitted plans. I have submitted estimates. No plans.

Q. Is it not a fact that the treatment which is contemplated there, is the treatment by sedimentation?

A. Yes.

Q. Nothing Else?

A. Well, nothing else has been formally recommended.

Q. Is it your belief that the discharge into the waters of the Upper Bay off Red Hook of 200,000,000 gallons of sewage per day, or the effluent of 200,000,000 gallons of sewage a day, treated by sedimentation alone, would be safe and sanitary?

A. I think that would depend very largely on the decision with regard to the passaic Valley sewer.

Q. Leave out of consideration the Passaic Valley sewer, Mr. Allen.

A. Supposing conditions to remain as they are now with
814 regard to the sewage conditions, I still think it would be questionable as to whether that would be a safe method of treatment to count on for all time.

Q. Well, would it be a safe method of treatment for the conditions which exist now?

A. Yes.

Q. There would be no nuisance created in your judgment in New York and Brooklyn, or the waters about New York and Brooklyn—I mean Manhattan and Brooklyn—by the discharge of this sewage?

A. No.

Q. Treated merely by sedimentation?

A. And Screening.

Q. And screening?

A. And Screening.

Q. Have you before you so that you can produce it, the exhibit which shows the percentage of dissolved oxygen in waters near Red Hook?

A. I think it is contained in that report that I read just before lunch.

Q. (Question repeated.)

A. I have them for Gowanus Bay, which is not very far from there.

Q. What are those figures?

A. 1917, down to 26 per cent.

Q. Have you also for the same years, the figures for the dissolved oxygen at Robbins Reef?

A. 42 per cent. Gowanus Bay, however, is not the same as the location off Red Hook.

Q. Have you, for the Red Hook location, any dissolved oxygen figures?

A. The only thing that would show it would be those photostat maps (referring to maps). I have nothing for 1917 or
815 1916; but for 1915 I have 69 per cent.

Q. Now, will you turn at that same date, to the percentage of dissolved oxygen at Robbins Reef?

A. 74 per cent.

Q. 74 per cent?

A. Yes.

Q. Is Red Hook nearer Manhattan and Brooklyn, or further, than Robbins Reef?

A. It is nearer Brooklyn and Manhattan than Robbins Reef.

Q. Is it nearer or further, with reference to the heavily polluted waters of New York Harbor?

A. It is nearer.

Q. What is the depth of water where the disposal outlet discharge is to be made under the plan at Red Hook?

A. I can not say without referring to the Government chart, but it would be in deep water. The island itself would be on the anchorage ground, which is shallow; but the outlet would be carried to the deep water; at least 40 feet below mean low tide. (Referring to map.) The channel depth there goes down to 74 feet. There is a very deep channel off there. The island itself would be in water that is probably not more than 16 or 18 feet in depth.

Q. You have not prepared any plan for the dispersion area on that proposed plant?

A. No.

Q. You have not located it?

A. No.

Q. What channel do you refer to when you say the channel is 74 feet deep?

A. (Referring to map.) The channel that is about a mile west of Red Hook Point.

816 Q. What channel are you referring to? Has it a name?

A. Yes.

Q. What is the name?

A. There is no name here. It is just deep water down there.

Q. Is it the Main Ship Channel?

A. That particular part is in the Main Ship Channel.

Q. That is practically the same as waters into which the Passaic Valley sewer is designed to discharge the effluent, is it not?

A. That particular part; but the discharge, not being made at that point, would not go to that depth. There is water of sufficient depth in almost any direction from there, even toward Red Hook itself, so that the most suitable channel would be selected for that discharge.

Q. What do you call sufficient depth?

A. I would not want to discharge in less than thirty feet; but forty feet would be required by the Government, so that it could not be less than forty feet.

Q. You have not designed the dispersion area, so that you would be unable to state the extent of that area, of course.

A. Yes.

Q. Are you prepared to make any statement as to how large that area should be?

A. No.

Q. Would you discharge through multiple outlets, or through single outlets?

A. Multiple outlets.

Q. On the basis of 200,000,000 gallons of sewage to be
817 disposed of at or near Red Hook at this date, what would you estimate to be the sewage to be disposed of from the area which now contributes to this sewage, in 1940?

A. I would not take any more to that point.

Q. You would not take any more to that particular point?

A. No.

Q. What would you do with the increased sewage from the district served by the intercepters?

A. The sewage outside of what is taken to Red Hook would be treated in isolated plants.

Q. What is the percentage of the sewage to be involved in the Red Hook plan, as compared with the total sewage discharge directly or indirectly into the waters of New York Bay, Upper New York Bay?

A. The amount discharged into New York Bay, directly or indirectly, I figure at 675,000,000 gallons—and this is 200,000,000 gallons.

Q. Less than a third at Red Hook?

A. Something less than a third, yes.

Q. Now in 1960, Mr. Allen, what do you estimate the total discharge into the waters of New York Bay, directly and indirectly, as likely to be?

A. 675,000,000——

Q. In 1960?

A. Oh, 1960?

Q. Yes.

A. 1,478,000,000 gallons.

Q. That is seven times the amount designed to be discharged at Red Hook, is it not?

A. Yes.

818 Q. None of the sewage under your plans is to be diverted and carried out to sea?

A. No. That from the Kill Van Kull passes down on the ebb current without going directly into the upper part of the Bay.

Q. It goes into the waters of Upper New York Bay, however, does it not?

A. It just passes down along the shore of Staten Island. It does not go up to this point, except on the return flood.

Q. Well, I ask you whether any part of the sewage which is estimated to be discharged directly or indirectly into Upper New York Bay in 1960 is planned or contemplated to be removed to sea, or to any point down the Bay, except that which is to be discharged at Red Hook, about 200,000,000 gallons?

A. No.

Q. Where is the remaining 12,000,000 gallons to be discharged?

A. What remaining 12,000,000 is that?

Q. From the 14,000,000 that are estimated to be the discharge of 1960.

A. Well, that is to be discharged at different points along the Upper East River, along the Lower East River and on the Hudson River, along the Upper Bay and along the shores of Staten Island.

Q. Will that discharge, in your opinion, create local nuisances?

A. No.

Q. Will that discharge create a general nuisance in the water of New York Bay?

A. No.

819 Q. A discharge under the conditions which you have indicated in your plans of 14,000,000 gallons per diem in 1960, will neither produce a local nor a general nuisance?

A. No.

Q. Will the discharge of 200,000,000 gallons sewage treated by screening and sedimentation, at or near Red Hook, produce a local nuisance, in your opinion?

A. That will depend on the condition of the Upper Bay at the time. I can not say.

Q. In the condition of the Upper Bay at present, will that produce it?

A. No.

Q. You have recommended it, have you not?

A. No, I do not think I have.

Q. You have presented a plan, have you not?

A. I have mentioned it in the report as a suggestion, but I do not think it was brought to the point of a recommendation by me.

Q. If the sewage amounting to 200,000,000 gallons a day which is planned under certain conditions to be discharged at or near Red Hook, is treated either by the activated sludge process, or the Miles acid process, is it your opinion that the discharge of the rest of the sewage of New York City, as far off as 1960, will be without injurious results in the waters of New York Bay?

A. Yes.

Q. That is your opinion?

A. That is my opinion, but I do not mean to say that in that case there may not be a nuisance produced by the Passaic Valley sewer.

Of course, that has nothing to do with the Passaic Valley
820 sewer.

Mr. Riker: I ask that the answer be stricken out.

The Commissioner: Note the request of defendants' counsel.

The Witness: I just wanted to make myself clear.

Q. In your opinion, if the 200,000,000 gallons of sewage in question, being that which it is contemplated to discharge at Red Hook, or at an island off Coney Island, is removed from the waters of the Upper Bay, the discharge of the remaining sewage from the City of New York directly and indirectly into the waters of Upper New York Bay will be practically without injurious effect indefinitely, will it not?

A. So far as I can see, yes, provided it is treated as planned.

Q. That treatment as planned does not involve any more treatment than sedimentation and screening, does it?

A. No.

Q. And when you say "indefinitely," you go beyond the limits of 14,000,000 gallons, do you not, a day?

A. I do not get that question.

Q. I say, when you say there will be no injurious effect for an indefinite time, you involve a larger discharge from the rest of the City of New York than 14,000,000 gallons per day, do you not?

A. Well, the conditions beyond 1960 are hardly predictable. I would not want to express any given opinion that would hold
821 good beyond that date. It is impossible to tell.

Q. Haven't you already given your opinion on your direct-examination, that it would be practically without injurious effect indefinitely? Didn't you say that?

A. That so far as I can see it would be.

Q. Is there any limit in your judgment to the amount of sewage which can be safely discharged into Upper New York Bay, if treated by sedimentation and screening?

A. There certainly is.

Q. What is it?

A. I never figured it.

Q. The amount would exceed 14,000,000 gallons a day, would it not?

A. Yes.

Q. Would it exceed 30,000,000 gallons a day?

A. I do not know.

Q. Can you not form an opinion?

A. I have an opinion that it would not exceed that. I think it would be a nuisance before it reached that figure.

Q. Why do you reach that conclusion when you say that 14,000,000 gallons a day will not be a nuisance?

A. That is a personal opinion. I have no figures to state. It is

just a personal opinion. There is a limit beyond which the sewage—beyond which the Bay could not take care of the sewage. I would not suppose that doubling the effluent say from 16,000,000 in a population, to 32,000,000, could safely be taken care of by sedimentation.

822 Q. You are testifying as an expert, are you not, Mr. Allen?

A. Yes.

Q. Why do you say that 14,000,000 gallons a day, if treated by sedimentation and screening, would be safe and innocuous, and 30,000,000 would not?

A. That is my opinion.

Q. On what do you base your opinion?

A. On general information and knowledge. I can not tell you in figures.

Q. And would 20,000,000 a day be innocuous?

A. It might.

Q. Would it, in your opinion?

A. I do not know.

Q. In your opinion, would it?

A. I can not say.

Q. You have no opinion on the subject?

A. No, sir.

Q. Can you not form an opinion on the subject?

A. No.

Q. When you said, as you did in your direct examination, that the waters of New York Bay will be safe and sanitary practically indefinitely if the 200,000,000 gallons contemplated to be disposed of, so that it was free from putrescible matter, were so disposed of, you did not mean what you said, did you?

A. Yes, I did. Perhaps I would make it a little clearer if I said that I did not think the City of New York is going to grow to a much larger size than 16,000,000 people.

Q. You think the limit of population will be likely to be reached in 1960, in other words?

A. Very close to it, yes.

Q. Do you think it will be 1960, or some date later that the limit will be reached?

A. Oh, some date later. I should say it was safe up to
823 that time. I have always considered that this plan was safe up to 1960.

Q. Why do you say that the removal of 200,000,000 gallons of sewage from discharge into the waters of New York Bay will render New York Bay safe and sanitary indefinitely, provided the rest of the sewage is treated by screening and sedimentation?

A. I do not think the effect of that 200,000,000 on the Bay is so important a matter in the plan of New York, as the relief of the Lower East River. That was the particular reason for carrying the sewage to an outlet island as planned by the Metropolitan Sewerage Commission.

Q. Then it is not the solution of the general problem of pollution of the waters of New York Bay so much as the removal of a local

nuisance now existing in the East River that you have in mind as desiring to be treated by this method?

A. Yes, except that in speaking of a local nuisance, my meaning is that this applies generally to the Lower East River.

Q. The conditions that exist in the Lower East River are those that need immediate relief?

A. Yes.

Q. And this outside disposal, either at Red Hook or outside the Lower Bay, is in your judgment, desirable, in order to relieve that condition?

A. Yes.

Q. Would that condition be removed by sedimentation and screening?

A. You mean locally?

Q. Yes.

A. No, I am afraid not.

824 Q. Why not?

A. Because I do not think that the sedimentation of all the sewage entering the Lower East River would produce sufficient effect to relieve the situation. That plan was considered carefully and rejected.

Q. Then the problem with which you have had to deal, Mr. Allen, was more particularly the relief of certain water areas than the general problem of the pollution of the Bay?

A. Well, it was both, both had to be taken into consideration.

Q. In what way is the general pollution of the waters of the Upper Bay taken into consideration by you, in dealing with the problem?

A. It was taken into consideration, in suggesting that 200,000,000 gallons be taken to Red Hook Island. I mean by that that in spite of the increased pollution of the Lower Bay due to that transfer of sewage, the Bay would have sufficient digestive power to take care of that amount of sewage provided the Passaic Valley sewer did not discharge a large amount at the same time.

Q. How much, in your opinion, is it contemplated that the Passaic Valley sewer will discharge at the time it is first put in operation?

A. I can give only a guess.

Q. Well, you are undertaking to say that the discharge of the effluent from the Passaic Valley sewer is going to alter the conditions in the Upper Bay. Now, how much sewer effluent in gallons do you contemplate as being likely to be discharged at the first operation of this sewer?

825 A. Why, I should say perhaps 150,000,000 gallons a day, but my objection is not to that first discharge. It is to the ultimate discharge that I had particular reference to.

Q. In 1940, is that the time when you had particular objections to offer?

A. 1940 and after, yes.

Q. How much do you estimate will be discharged at the maximum of discharge through that sewer?

A. Something over 300,000,000 gallons.

Q. You have testified, Mr. Allen, that the increase of the discharge of sewage directly and indirectly into the waters of the Upper Bay to the extent of 14,000,000,000 gallons will not produce a nuisance, have you not?

A. Yes.

Q. Why do you say that the discharge of 350,000,000 from the Passaic Valley is going to cause a nuisance?

A. The figures of oxygen have been going down consistently from year to year, and I can only say as a matter of opinion that it would be inadvisable to add any more to the threatened pollution of the Bay than is necessary. If 300,000,000 gallons a day were added to the 200,000,000 gallons a day from Brooklyn and all the sewage that comes down the East River and the Hudson River, there would be a serious danger of a nuisance.

Q. But you have said that the discharge of an effluent from the Brooklyn sewage, discharge at or near Red Hook, after treatment by screening and sedimentation, will not produce a local

826 nuisance?

A. No, I did not say that for 1960.

Q. It is not to be increased in 1960, is it?

A. No; but the pollution of the Bay will be greater then.

Q. But you have said, have you not, Mr. Allen, that removing the polluting effect of this 200,000,000 gallons of sewage from the waters of the Lower East River, the discharge of sewage treated by screening and sedimentation up to 12,000,000,000 gallons from the rest of the Greater City of New York, Will be without injurious effect to the waters of the Upper Bay?

A. Yes, they will affect the waters of the Upper Bay, but will not affect it to a sufficient extent to make it a nuisance. I consider that in spite of the projected work, that there will be very little relief in the pollution of the Upper Bay, as a whole, in 1960, above what it is now. I do not think it will be any better as a whole in 1960 than it is now.

Q. Speaking generally, Mr. Allen, from the figures of dissolved oxygen, where are the danger points in the waters of New York Harbor?

A. The most critical point is in the Harlem River; then all the Lower East River.

Q. At about the mouth of the Hudson River?

A. There are short times in the summer when the oxygen has gone down pretty well in the Hudson River, but I don't anticipate with the treatment plants that are planned, there will be any nuisance in the Hudson River.

827 Q. Now, the increased population that you count in 1960 is located where, chiefly?

A. That is very largely in Queens and The Bronx.

Q. Above the mouth of the Hudson?

A. Yes.

Q. And above the mouth of the East River?

A. Yes.

Q. And the sewage from that increased population will discharge through the East River or through the Hudson River?

A. Through the East River.

Q. Any part of it through the Hudson River?

A. That carried to 155th Street, yes, sir.

Q. And you do not anticipate any injurious results from that increased discharge, do you, of the waters at the mouth of the Hudson and in the East River?

A. No.

Q. And that increased population is estimated to discharge at least 600,000,000 gallons a day?

A. Yes, 675,000,000.

Q. Now, coming down through the East River and a part of the Hudson River, and producing no injurious results?

A. And the Upper Bay and the Kill van Kull.

Q. And producing no injurious effect?

A. That is right.

Q. And in 1940 the discharge from the Passaic Valley outlet at Robbins Reef of 350,000,000 gallons a day will produce a nuisance?

A. It would not by itself, if there was no New York sewage coming down, too.

Q. Well, if you add another 100,000,000 from the New York sewage, in addition to the 600,000,000 that you are esti-
828 mating in 1960, will that produce a nuisance?

A. I do not know.

Q. You have no opinion on the subject?

A. No.

Q. Will 200,000,000 additional sewage discharged from Greater New York, create an injurious result, in your opinion, above the 600,000,000 we are calculating on?

A. I do not know.

Q. You have no opinion?

A. No.

Q. Would 350,000,000 gallons of sewage produced in New York and discharged into the waters of New York Bay and those tributary to it, produce an injurious effect on the waters of the Bay, in your opinion.

A. I do not know.

Q. Have you any opinion in regard to it?

A. I think by that time it would be likely to be—a good deal depends on the method of treating the sewage. Now, in some of this sewage that is coming down, some treated by sedimentation and some by screening, if that additional volume should produce a nuisance, I think it would be necessary to carry the treatment to a further point.

Q. I did not ask you that. I asked you whether, if it was treated by screening and sedimentation, it would create a nuisance?

A. Oh, I should think quite likely it would.

Q. You should think quite likely it would?

A. Yes.

Q. But 600,000,000 additional to what is being discharged now, would not create a nuisance?

A. That is not what is being discharged now.

829 Q. In addition to what is being discharged now, I said.

A. 675,000,000, I believe, was the estimated future discharge into the Bay and its tributaries.

Q. In addition to what is being now discharged?

A. No, not in addition.

Q. How much is the estimate of the amount now discharged into the Bay and its tributaries?

A. 675,000,000 gallons is the present amount.

Q. And the estimated amount for 1960 is how much?

A. 1,486,000,000 gallons a day.

Q. The increase then of 1960 is how much estimated increase?

A. More than double what it is at present. About 800,000,000 gallons.

Q. Now if you take out 200,000,000 for discharge at Red Hook on Coney Island, you have an estimated increase of about 600,000,000, haven't you?

A. Yes.

Q. And that, you say, will produce no injurious effect in the waters of Upper New York Bay?

A. No, I think not.

Q. At what limit of discharge, additional to what is being discharged now, do you place the danger point?

A. That would be impossible to say.

Q. 100,000,000 more?

A. I do not know.

Q. 200,000,000 more?

A. I do not know.

Q. 300,000,000 more?

A. I do not know.

Q. 350,000,000 more?

830 A. I do not know.

Q. That is the amount that is calculated for the Passaic Valley, 350,000,000 isn't it?

A. Yes.

Q. You have expressed an opinion as to that, haven't you?

A. If that was discharged directly into it, I think it would.

Q. A discharge of 200,000,000 directly into the Bay at Red Hook would not produce a nuisance?

A. I do not know.

Q. Haven't you said in your opinion it would not?

A. No, not if it were merely settled in tanks. I do not anticipate any question as to the disposal of the present sewage that would be carried to Red Hook Island and settled in tanks; but if 200,000,000 were discharged there in 1960, and the Bay were receiving the indirect discharge of the population at that time, I would not want to say that the effluent would be suitable, without further treatment.

(Whereupon, an adjournment was taken to to-morrow, Wednesday, August 6th, 1919, at 10:30 o'clock a. m.)

New York, August 6th, 1919,

831 10:30 o'clock a. m.

Present: Parties as before noted.

KENNETH ALLEN, recalled:

Cross-examination (continued).

By Mr. Riker:

Q. Mr. Allen, did you complete your studies for sewage disposal for the Greater City of New York?

A. No.

Q. You did not?

A. No.

Q. What remains to be studied?

A. This shows on Exhibit 238, as not being colored. That includes, by the way, this Red Hook project, of which we have been speaking.

Q. The Red Hook project?

A. Yes.

Q. Have you made an estimate of cost of the combined total sewage disposal plants that are under consideration, the estimate of the cost?

A. Yes, not recently.

Q. Well, when did you make it?

A. I made one when I was with the Metropolitan Sewage Commission, and most of that has been re-estimated since, and is shown on one of these exhibits.

Q. Can you state the total cost of the works on each end of the study, the estimated costs?

A. Yes, that is shown in the exhibit.

Q. You can not tell us without referring to the exhibit?

832 A. No.

Q. Can you approximate it?

A. I prefer to take it from the exhibit.

Q. Will you turn to the exhibit, then, and get it.

A. The total cost, including the East River and the Upper Bay and Brooklyn and the Harlem River, is estimated at $41,403,000, if the Ocean Island project is carried out; and $32,108,000 if the Red Hook Island project is carried out. To that should be added, to the total, the screening plants on the Hudson River and any plants on Staten Island, and below the Narrows.

Q. Have you made an estimate of the cost of the screening plants on the Hudson River?

A. I have made rough estimates of those, but I do not attach great importance to them, because the cost of screens is a very problematical matter. The Dyckman Street station complete, cost about $76,000.

Q. How many such screening plants are under contemplation for the Hudson River, on Manhattan Island?

A. I can give you that exactly, if you would like me to refer to it.

Q. Turn to it and give it to us exactly.

A. There are 12 shown on this plan, but two of those areas will probably be combined, reducing that to eleven.

Q. Dyckman Street cost $72,000?

A. About $76,000.

833 Q. About $76,000?

A. Yes.

Q. That is, constructed?

A. Yes; with the exception of the outlets.

Q. It is the only one that is, in fact, constructed?

A. Yes.

Q. With reference to the East River front of the Borough of Manhattan, are there screening plants contemplated over that front?

A. No.

Q. What is contemplated to be the treatment for that sewage which now discharges along the East River front?

A. The East River front of Manhattan is proposed to be taken care of by tanks.

Q. Why is there this different treatment contemplated for the East River front from the West and Hudson River front?

A. On account of the greater pollution of the East River.

Q. The greater pollution?

A. Yes.

Q. How many of those plants are contemplated for the East River front?

A. Six in Manhattan, besides the Wards Island plant.

Q. Is the Wards Island plant, as planned, of the same character as the six on the East River front?

A. So far as planned, they are, but it is possible that some more refined process may be carried out at that location.

834 Q. In all of the plants as contemplated and planned by you, or under study, have you incorporated anything more than screening and sedimentation?

A. No; with the exception of the possible location of a plant on the eastern end of Jamaica Bay. If that should be built, it would undoubtedly provide some more complete purification.

Q. Jamaica Bay——

A. And also it is quite possible that if a plant is located at Red Hook Island, some more complete process would be required at that point.

Q. Do the studies that have been made for the Red Hook plant involve anything, except screening and sedimentation, so far as they have gone?

A. The question of other processes has been described in one of these exhibits as possibly applicable to that point. The Red Hook Island project has never been recommended, except by the Sewer Plan Commission which went out of commission in 1914; so that the question of disposal at that point is not fixed.

Q. Is not the matter of the disposal of the sewage which might go to Red Hook Island if it was established there in determining the

alternative, either to be disposed of there, or at the island disposal off Coney Island?

A. Yes; so far as I know.

Q. And the difference in cost between the Red Hook disposal and the Coney Island disposal is about $7,000,000?

A. About $4,000,000.

Q. About $4,000,000?

A. I mentioned $7,000,000 I think at first, and when I
835 referred to my notes, I found it was about four.

Q. $4,000,000. The taking of the sewage out to the ocean off Coney Island would be the final disposition of it, would it not?

A. Yes.

Q. Would it, in your judgment, require any treatment to be safely disposed of at that island?

A. That depends on what you mean by "safely." I think treatment there would be desirable, but I am not sure that the tank would be necessary. That was, however, provided for in the plans.

Q. And included in the cost of the disposal?

A. Yes.

Mr. Riker: That is all.

Redirect examination.

By Dr. O'Sullivan:

Q. What do you mean by "tank treatment," Mr. Allen?

A. Sedimentation for a certain period in small reservoirs to permit the solid matter to settle at the bottom, and be removed by itself, leaving the effluent comparatively free from solids.

Q. Is screening and sedimentation a successful and efficient method of disposing satisfactorily, of fresh sewage?

A. Yes, for the removal of a large part of the most objectionable material in the sewage.

Q. Is it a successful means of treating septic sewage; and if so, what reasons can you give?

836 A. Septic sewage has been acted upon by the agency of bacteria, and by the fact that it is septic it is a sewage that is not fresh. That is, it has flowed through the sewers for some time, and in doing this it has been comminuted, and the larger particles broken up into finer solids or transformed into colloids, so that it is very difficult to secure their removal either by fine screens, or by sedimentation. The fine material will pass rapidly through any practicable screen, rendering it an inefficient method of treatment.

Q. Are you familiar with the Passaic Valley trunk sewer project?

A. In a general way.

Q. If sewage has to travel over 21 miles, much of the transit being in flat grades, and has been many times pumped and siphoned, and is septic when it reaches the disposal works, would you expect efficient treatment from screening and sedimentation if the detention period would not exceed an hour or an hour and a half?

A. I should expect to get a very small reduction in the solids or putrescibility of the sewage.

Q. Is the sewage of the City of New York fresh, stale or septic, at the outlets?

A. As a general proposition, it is very fresh.

Q. Taking Manhattan Island, what would be the age of it, when it reaches the recipient waters?

A. I should say it would average about half an hour, vary-
837 ing from 15 minutes up to perhaps an hour, in some cases.

Q. Taking the forecast for the conditions in 1960, what were those based on?

A. The forecasts were based on present conditions, as regards pollution, and the additional sewage tributary to the waters by 1960, assuming that the tidal conditions and the river flow are the same as now.

Q. What factors did you take into consideration, and on which were based your estimates and forecasts for 1960, as to the sewage conditions, and as to the pollution resulting therefrom, in the harbor waters of New York?

A. The principal factor I made use of was the dissolved oxygen present in the water, that being the best single indication that I know of for that purpose.

Q. Did you give study and thought to the condition of the sewage itself?

A. I did, the sewage from Manhattan would be very fresh.

Q. Did you take into consideration the necessary treatments that you prescribed, and which would to some extent, or to a large extent, eliminate the polluting qualities of the discharged material?

A. I did.

Q. Did you make any estimates or forecasts beyond 1960?

A. I did not. Any estimate of conditions beyond that date it has seemed to me would be futile, as it is impossible to tell how the city will develop beyond that. In fact, population data more than 25 or
30 years in advance, is subject to more or less review, and the
838 supposition has been that as time progressed, the design of works which have not been established, would be subject to modification, to meet the conditions at the time when installed.

Q. Why are you unable to answer questions as to the accesses of population after 1960?

A. Because no study has been made beyond that date. That has seemed to be the limit to which it would be practicable and proper to expend time and money in making studies.

Dr. O'Sullivan: That is all.

Recross-examination.

By Mr. Riker:

Q. Mr. Allen, did you not tell me yesterday that the reason why you did not do it was because you assumed and concluded that the limit of population would have been reached by 1960?

A. I do not remember that I said just that.

Q. Well, just what did you say?

A. I remember saying that the population beyond 1960, in my opinion, would be not greatly increased, so that plans for the year 1960 would probably be quite adequate for the time beyond that.

Q. So that if you studied the problem as of 1960, you would, in your judgment, have studied it practically for all time, would you not?

A. In general.

Q. Now, taking the extreme point of intercepting sewers that are to be served by an outlet at Red Hook, or thereabouts,

839 can you state the length of flow?

A. I can not, precisely. I should suppose that the average of the sewage would be between four and five hours.

Q. Well, have you been dealing with the averages in testifying in finding fresh, stale, and septic sewage?

A. I have.

Q. You have?

A. Yes. I gave figures in my evidence both averages and extreme ages.

Q. Do you think that the question of staleness, freshness, or septicity would be determined by the extreme length of the sewer, or by the average length of the sewer?

A. I think it would be determined by both; that is to say I think if a small volume of sewage came from a long distance and was diluted by a large volume from a very short distance, the character of the sewage at the plant would partake of that of the larger volume received at short distance, but if the large volume came from the extreme end, then I would consider that it would partake more of the character of that sewage.

Q. Well, can you state in an approximate way, the extreme length of the connecting sewers that would be discharged into the Red Hook outlet, if that was established; I am now speaking of miles, distance?

A. No, I can not. I might be able to estimate that from the map, if I had it before me.

840 Q. Will you take the map and see if you can estimate it.

A. I should think the extreme length would be about eight miles.

Q. Would that sewage, when delivered at the Red Hook outlet, be comminuted?

A. Somewhat.

Q. What length of outfall pipe would it have been traveling through?

A. You mean the intercepter?

Q. Yes.

A. There are about 6½ miles of intercepter.

Q. Do you remember testifying that you were informed that at Schenectady the sewage traveled six miles, the extreme, 4½ at the average, and was stale?

A. I do.

Q. Do you think the sewage when delivered at Red Hook, will be fresh or stale?

A. Stale.

Q. The processes of sedimentation, if applied at Red Hook, then, would be ineffective?

A. I do not think they would be very effective; not as effective as could be desired.

Q. But nevertheless, you think it is a safe place to discharge 200,000,000 gallons of effluent treated in that way?

A. My opinion is that if 200,000,000 gallons were discharged there and treated by sedimentation and screening, that would be satisfactory up to 1960, provided the Passaic Valley sewer did not discharge at Robbins Reef; but I would not like to assert that it would be; in that case, further treatment should be given the sewage, and for that reason the report was prepared, which was submitted as an exhibit on the two other processes that might
841 be supplemented.

Q. Will you please eliminate the Passaic Valley sewer from your answer, as you were not asked about that, and confine yourself to the discharge of 200,000,000 gallons of effluent at an island off Red Hook, treated by screening and sedimentation, as to whether or not it will produce a local nuisance under the present conditions.

A. That depends very much on the condition of the Bay, and that, in turn, depends on the plans of the Passaic Valley Commission, so that I can not answer that question.

Q. I asked you to eliminate the Passaic Valley sewer; it is not in operation, is it?

A. No. If you mean by that that I eliminate the consideration of that being put into operation——

Q. I asked you the present conditions, under present conditions.

A. Under present conditions, I think it would be a satisfactory mode of disposal.

Q. Would there be created a local nuisance at the point of outlet?

A. No, I do not think there would.

Q. Now, Mr. Allen, if the disposal plant or the sewage under consideration, which is the sewage contemplated to be discharged off Red Hook, is taken to an island off Coney Island, what will be the age of the sewage when discharged there?

A. I should say that would be near ten hours or more.

Q. Average?

A. No, extreme.

842 Q. Well, the extreme; what would you place the average at?

A. Eight or nine.

Q. What would be the length of the intercepter?

A. The intercepter and the outfall tunnel together would be about 14 miles long.

Q. In what condition, in your judgment, will the sewage be delivered at the island off Coney Island, if such plan is adopted?

A. Septic.

Q. Do you recommend the treatment of the sewage by sedimentation?

A. That has been recommended. I have not made up my mind whether that will be necessary or not.

Q. Did not you say a little while ago that you thought it ought to be treated by sedimentation?

A. No.

Q. What did you say?

A. I said I thought it probably would not be necessary.

Q. Probably not be necessary to treat it at all?

A. Yes. I think it should be screened, to take out the large floating solids.

Q. Coarse screening only?

A. Possibly; I have not made up my mind about that.

Mr. Riker: That is all, Mr. Allen.

By Dr. O'Sullivan:

Q. Mr. Allen, in answer to Mr. Riker's questions, you stated that the trunk intercepter at Red Hook would be about eight miles in length?

843 A. The intercepter would be the longest sewer distance.

Q. That would be the maximum?

A. The maximum.

Q. Does the grade of the trunk or the intercepter retard or increase velocities in the sewer?

A. It does. With an increase of grade, you have an increase in the velocity, and a decrease in time, in reaching the outlet.

Q. What is the length of the Passaic Valley trunk sewer at its outfall at Robbins Reef?

A. I do not know.

Q. Do you know whether or not it is 26 miles?

Mr. Riker: The question is objected to. The witness says he does not know.

The Commissioner: Note the objection of counsel for the defendants.

A. I have understood that it was nearly thirty miles.

Q. And that much of the grade is flat?

A. Yes.

Dr. O'Sullivan: That is all.

By Mr. Riker:

Q. What do you know about the length of the Passaic Valley sewer, of your knowledge?

A. I have seen figures in the Passaic Valley report.

Q. Do you remember what they are?

A. I remember they were in the vicinity or neighborhood of 25 miles.

Q. What did that cover?
A. To Passaic and possibly a short distance beyond.
Q. To Passaic?
A. Yes—I beg your pardon, Paterson.
844 Q. And what do you know about the grades?
A. I can not state what the grades are.

Mr. Riker: That is all.
Dr. O'Sullivan: That is all, Mr. Allen.

EARLE B. PHELPS was called as a witness on behalf of the Complainants, and having been duly sworn, testified as follows:

Direct examination.

By Dr. O'Sullivan:

Q. What is your full name, Professor?
A. Earle B. Phelps.
Q. Where do you reside?
A. Ridgewood, New Jersey.
Q. What is your profession?
A. Sanitary Engineer and Chemist.
Q. Will you state where you received your education, and what your professional experience is, as a sanitary engineer and chemist.
A. I graduated from the Massachusetts Institute of Technology in 1899, in the Department of Chemistry. I was employed for four years by the Massachusetts State Board of Health as Assistant Bacteriologist at The Lawrence Experiment Station, and engaged in experimental studies of water and sewage purification.

I was then employed to conduct similar studies at the Sanitary Research Laboratory of the Massachusetts Institute of Tech-
845 nology, where I remained for ten years, being first a Research Associate, then Assistant Professor, and finally Associate Professor of Chemical Biology. I gave advanced courses of instruction in the purification of water and sewage at the Institute for about five years. During this period I was also appointed an Assistant Hydrographer in the United States Geological Survey, and conducted for that Government bureau, researches in the disposal of industrial wastes. I was for two years consulting engineer for the New Jersey State Sewerage Commission, and in connection with my consulting practice, have been retained by many municipalities in connection with water and sewage problems.

In 1910, I was retained, together with Colonel (now General) William M. Black, U. S. A., by the Board of Estimate and Apportionment of New York City, to make a study, extending over one year, of the general problem of the pollution of New York Harbor and the remedies therefor.

In 1913, I was appointed Professor of Chemistry at the Hygienic Laboratory, U. S. Public Health Service, where for five years I carried out extensive researches in sewage and industrial waste dis-

posal; the reaeration of water, and kindred subjects. This work was done in many parts of the country, and involved expenditures ranging from $25,000 to $40,000 per annum.

846 In 1914-1917, I was appointed Consulting Sanitary Engineer of the International Joint Commission, and made for that Commission an extensive study of possible remedies for the pollution of the international waters between the United States and Canada. My recommendations, involving total expenditures of about twelve million dollars, on the part of the offending cities, have been approved by the Commission, and a beginning has already been made toward putting them into effect in many places.

I resigned from the Government service in March of this year, and am now in private business.

Q. Prof. Phelps, have you read the testimony given in this case by Mr. Whipple?

A. Yes.

Q. State what after you had read it, were the points of agreement or disagreement.

A. I have read Mr. Whipple's testimony in this case, and am not in agreement with him in many matters. In answer to the question, (page 394 of the stenographic minutes), "So far as the pollution of the waters of Upper New York Bay and the Hudson River and the East River are indicated by these samples at the two different times, are you able to state any conclusion as to the comparative pollution?" He said "I do not wish to generalize too much from two sets of samples only, but in so far as these samples go, they show that the amount of dissolved oxygen in 1919, May 3, was greater in almost every case than at the corresponding stations and

847 depths on November 3, 1909."

He freely admits both on direct and on cross-examination that the comparison is not entirely satisfactory, in that the dates do not correspond, the locations were only approximate, the salinity was not the same, and an insufficient number of samples were taken. He however concludes (page 398) that the biochemical depletion of oxygen "was not substantially greater in 1919 than in 1909."

I agree that the comparison is not satisfactory, and furthermore, am of the opinion that no reliable conclusions whatever as to the general condition of the waters of New York Harbor can be drawn from such a brief study as was made by Professor Whipple.

Q. To determine the true conditions, have you studied the results of the various oxygen and bacteriological work since 1909; and if so, state what your studies consisted of; the number of samples you have studied, and if you have taken any samples yourself, and if so, state.

A. In order to determine the true conditions as accurately as possible, I have made a careful study of some 2,524 analyses that are in evidence in this case, covering all parts of the harbors and rivers, and extending continuously over a period of ten years. In addition, and to complete the record fully to date, I have personally examined about 290 samples during the month of July,

848 1919. As these 1919 data are not in evidence, I will refer to them first.

During the first week of July, I organized a party to work under my supervision, consisting of:

Mr. W. T. Carpenter, Chemist.
Mr. P. A. Frost, Biologist.
Mr. A. S. Bonney, Bacteriologist.
Mr. John McManus, Hydrographer.
Mr. Harry Lehnpuhl, Hydrographer.

On July 12, Mr. McManus was relieved, and Mr. Patrick McDonough took his place. An experienced boatman was engaged to transport this party and its equipment. A chemical laboratory was set up on board, and the whole of the chemical work, and a part of the biological work, was done in the boat. The following examinations were made:

Temperature.
Chlorine.
Dissolved oxygen.
Bacteria at 20°.
B. coli.
Microscopic examination.

I organized the work of this party, and during the first week went with it, selected the sample stations, kept the records, and saw every step of the work carried out, both afloat and ashore. Later, when the work was running smoothly and regularly, I made less frequent trips, and Mr. Carpenter reported to me the progress of the work. I made all computations, personally checked the chemical standards, made miscroscopical examinations, checked the counting and
849 recording of the bacteria, and in general supervised the work in such a way that I am entirely satisfied as to its accuracy.

Q. Now, the results of this work: Did you tabulate them, and have you these tabulations with you?

A. The results of this work I have had tabulated by a draftsman working under my immediate observation, and the tables I have checked against the original records. I have here a table marked: "Results of Examinations of the Water of New York Harbor, July, 1919," on six sheets numbered serially from one to six, bearing my signature. Sheet No. 7 contains a description of the stations. These are blueprints from the original tables, and give accurately the results of my work.

By Mr. Riker:

Q. Professor, these tables which are produced here, and which it is proposed that you should read into the record, or submit in the form of tables, will you point out what work you did personally?

A. No, sir, I could not exactly. The magnitude of the work was such that it was impossible for me to do it all, and I had to have a great deal of assistance. I can indicate in a general way. I have indicated on the record what part I did actually with my own hands.

Q. If you are testifying from your recollection and giving your own personal part in the work, will you state what you did in the taking of the samples.

A. I did nothing in the taking of the samples, practically
850 nothing.

Q. Do you know of your own knowledge, that they were taken at the point at which they are alleged to have been taken?

A. A large number of them were taken under my immediate observation.

Q. How many of them?

A. I can not state that, Mr. Riker, exactly; perhaps one-third of them.

Q. Can you point out the ones that were taken under your observation?

A. I think I could, by going back to my notes, which I have not brought with me. I do not recall the days on which I went with the boat. I can not do that from memory, however.

Q. Now, after the taking of the samples, the work of examination and determination was made in the boat?

A. The chemical work was done entirely in the boat, and the bacteriological work was started there.

Q. How much of that did you do personally?

A. I did none of that personally.

Q. Who did it?

A. Mr. Carpenter did the chemical work under my immediate observations on those days, on which I was present. I personally checked all the solutions; that means that I compared the standards to see if they were correct, and I personally made a good many of the bacteriological counts, and the microscopic examinations after we returned to the laboratory.

851 Q. Confining your testimony now to what you did in the way of determining dissolved oxygen content; you say that you checked the standards. What do you mean by that, exactly?

A. The determination involved the use of certain standard solutions. The integrity of the results is intimately bound up with the correctness of those solutions. All those solutions are used on the boat, and after each day's run, they are taken back to the laboratory and checked against more substantial laboratory standards. That work I repeated after Mr. Carpenter; after he had done it in his own laboratory, I did it in my laboratory against my own standards.

Q. In checking the standards, did you determine the oxygen content?

A. No, sir. That determined the proper strength of the solution which in turn was used to determine the oxygen content.

Q. It merely determined, did it not, the machinery or tools by which the dissolved oxygen was examined?

A. Yes, sir. You might say the accuracy of the yard-stick used in the measurement.

Q. Now, what else was done with the samples besides the treatment through Mr. Carpenter, of the dissolved oxygen?

A. Well, the temperatures were read on each sample.

Q. Did you do that?

A. I did that personally when I was on the boat on those days when I made the trips. That was one of my duties.

852 Q. How many days of the total were you present on the boat?

A. I have already stated I can not tell you accurately without referring to my notes.

Q. What other observations were made on the samples?

A. The chlorine was determined on each sample.

Q. Who did that?

A. Mr. Carpetner did that.

Q. Did you have any part in doing it?

A. No, sir.

Q. What else was done with the samples?

A. They were concentrated on the boat, that is, filtered through sand and reduced in volume from about half a litre to five c.c.'s, for the purpose of making a microscopical examination. That part of the work was done on the boat.

Q. Did you do it?

A. No, sir.

Q. Had you any part in doing it?

A. No, sir.

Q. Was that generally for the purpose of making the bacteria count?

A. No, sir. That was done for the purpose of making a micro-organism count. It appears only on Sheet No. 1. We discontinued that work at the end of the week.

Q. Who made the record at the time of the taking of the samples?

A. I made that record myself on those days on which I accompanied the party.

Q. You can not say how many of those observations were made by you, I suppose?

A. I have already stated approximately, one-third of them, but I can not state more exactly.

Q. You can not point out, as you have said already, which
852 ones they were?

A. No, sir.

Q. Who took the record of high water at Governor's Island?

A. I was responsible for that, which was inserted at a later date, not at the time the collections were made.

Q. And the memorandum as to tidal current, who furnished that material?

A. I made that note on those days on which I was present, and on other days Mr. Carpenter kept all the records.

Q. Now, Sheet No. 1, Professor, is the only sheet that you had anything to do with personally, is it not?

A. Oh, no, sir.

Q. What other ones did you have anything to do with personally?

A. I had a good deal to do with all of them personally.

Q. Were you present on the boat at any other time than the times that were indicated on Sheet No. 1?

A. Yes, sir.

Q. What other times were you present?

A. I have already said I can not identify the particular days, be-

cause I did not consider that a matter of special import. I made it a rule to go on the boat at least once a week during this study, and I went continuously during the first week, until it was organized and well-running.

Q. Well, you went continuously the first week, professor, beginning with July 9, did you not?

A. Yes, sir.

Q. And the business days of the week were the 9th, 10th, 11th and 12th—four days?

854 A. Yes, sir.

Q. Did you go next week at all?

A. Yes, sir, I went one day on each of the following weeks.

Q. What days were they; have you got any memorandum of them?

A. I think perhaps I can recall them, from the samples that were taken (perusing papers); yes, from the samples that were taken on the 15th, I recognize that as the day of that week I made the trip. I do not think I can recall any of the succeeding days, what particular day it was, except I went each week one day. In addition to that, I saw the work that was done ashore, at more frequent intervals than that.

Q. You saw work that was done on shore upon samples, as to the accuracy of which you had no personal knowledge?

A. Yes, sir.

Q. None of that work on shore had to do with dissolved oxygen, did it?

A. Only the checking of the solutions that I have referred to.

Q. That is, the checking up of the yard-stick, as you have called it?

A. Yes.

Q. The determination of the oxygen content had been made in accord, as you understood it, on the boat, before you came into contact with the standards, for the purpose of checking them up?

A. Yes, sir.

Q. Am I right in assuming that you selected the station at which the samples were to be taken?

855 A. Yes.

Q. Do you know whether they were actually taken at those stations?

A. I know all these days on which I traveled on that boat, they were actually taken at those stations, and I have reason to believe they were on the other days.

Q. What reason have you to believe that?

A. My confidence in the Assistant Chief of the party, whom I have known for a period of 12 or 15 years, and worked with on a great many occasions.

Q. So far as your testimony has gone now, you identified five days when you were personally present; is that correct?

A. Yes, that is so.

Q. And you can not identify any others?

A. No, sir.

Q. Is there another sheet besides the six?

RESULT OF EXAMINATION OF NEW YORK HARBOR WATERS
JULY-1919

SAMPLE NO	DATE JULY	TIME	HIGH WATER GOVD'S D'Y OF U.S. TIDE TABLE	TIDAL CURRENT	STATION	DEPTH FT.	TEMP C.	CHLORINE P.P.M.	SEA WATER %	LAND WATER %	DISSOLVED OXYGEN SAT. VALUE P.P.M.	DISSOLVED OXYGEN FOUND P.P.M.	DISSOLVED OXYGEN PER CENT SATURATION	BACTERIA PER C.C. AT 20° C	BACTERIA PER C.C. B. COLI	MICRO-ORGANISMS PER C.C. STANDARD UNITS	MICRO-ORGANISMS PER C.C. PREDOMINANT GENERA
1	9	6.50 P	3.30 A	EBB	1	1	23	4000	22	78	6.35	6.5	102	300	10	6	MICROSIRA
2					1	36	22	8200	46	54	6.15	4.2	52	600	10	5	"
3		12.35 P		EBB	2	1	23	4600	24	76	6.30	6.2	98	900	10	14	"
4					2	47	22	8.00	45	55	6.16	4.0	64	1200	10	5	"
5		1.50 P		EBB	3	1	23	5.00	28	72	6.30	6.3	100	1,200	10	10	"
6					3	89	21	10.00	36	64	6.13	4.8	59	600	10	7	"
7		3.15 P		SLACK	7	1	22	9200	46	54	6.15	5.0	61	1700	100	15	"
8					7	40	21	11.00	68	32	6.05	3.9	48	600	10	12	"
9	10	9.35 A	6.05 A	EBB	12	1	21	12800	71	29	7.91	4.1	52	900	10	27	"
10					12	40	21	12500	70	30	7.86	4.1	52	200	0	11	"
11		9.45 A		EBB	13	1	21	12500	70	30	7.93	3.5	44	2,000	100	18	"
12					13	43	21	12600	70	30	7.92	3.9	49	1900	0	34	"
13		10.05 A		EBB	6	1	21	12500	70	30	7.95	4.1	52	800	100	11	"
14					6	33	21	12600	70	30	7.92	4.6	58	100	0	9	"
15		10.25 A		EBB	7	1	21	12360	68	32	7.94	4.5	57	1600	100	1	"
16					7	43	21	12700	72	28	7.91	4.6	58	400	100	3	"
17		10.20 A		EBB	8	1	21	12200	68	32	7.95	4.5	57	1600	10	11	"
18					8	35	21	13000	72	28	7.88	4.2	53	400	100	4	"
19		10.50 A		EBB	14	1	21	12600	70	30	7.92	4.8	61	900	10	1	"
20					14	34	21	13400	76	24	7.88	5.3	68	300	0	2	"
21		11.20 A		EBB	15	1	21	13500	75	25	7.84	5.5	70	500	10	5	"
22					15	79	21	12900	76	24	7.82	5.7	73	700	0	4	"
23		11.42 A		EBB	16	1	21	12200	73	27	7.86	5.3	67	1200	100	12	"
24					16	83	21	13000	77	23	7.82	5.2	67	700	10	8	"
25	11	9.29 A	6.45 A	FLOOD	6	1	21	12360	68	32	7.94	4.2	53	1900	10	9	"
26					6	32	21	13000	72	28	7.88	4.0	51	300	10	3	"
27		9.32 A		FLOOD	7	1	21	11600	64	36	8.00	3.9	47	2000	10	20	"
28					7	46	20	12900	72	28	7.97	3.9	49	470	10	9	"
29		9.42 A		FLOOD	8	1	20	11600	64	36	8.16	3.1	38	6500	100	32	"
30					8	33	19	12400	69	31	8.08	3.6	45	900	10	2	"
31		10.00 A		EBB	12	1	21	12300	68	32	7.94	3.1	39	2,500	100	80	"
32					12	45	19	12300	68	32	7.65	3.1	41	600	100	10	"
33		10.12 A		EBB	13	1	21	12300	67	33	7.96	3.2	40	2,500	100	17	"
34					13	46	20	12100	67	33	8.12	3.6	44	4500	100	5	"
35		11.03 A		EBB	10	1	21	12600	69	31	7.97	2.4	28	3100	100	36	"
36					10	32	21	12400	68	32	7.92	2.7	34	2400	10	9	"
37		11.30 A		EBB	9	1	21	11600	64	36	8.00	1.6	20	2700	10	36	"
38					9	33	21	12400	67	33	7.97	2.2	28	800	100	28	"
39		11.44 A		EBB	11	1	21	12400	67	33	7.97	2.1	26	700	10	28	"
40					11	30	21	11900	66	34	7.98	2.1	26	2800	100	49	"
6	12	10.00 A	7.30 A	SLACK	4	1	21	9600	53	47	8.12	2.8	35	16000	100	15	"
41					4	48	21	11800	67	33	8.05	2.8	35	1300	10	6	"
42		10.40 A			5	1	21	10000	56	44	8.13	3.2	39	5300	100	10	"
43					5	38	21	10800	60	40	8.07	3.3	41	1000	10	2	"
44		11.05 A		EBB	6	1	21	12200	69	31	7.93	3.1	41	1700	100	5	"
45					6	30	20	12800	71	29	8.05	4.8	58	800	10	2	"
46		11.11 A		EBB	7	1	21	12400	69	31	7.94	4.2	55	3000	10	6	"
47					7	39	20	12600	70	30	8.07	4.3	58	1100	10	3	"
48		11.18 A		EBB	8	1	21	11900	66	34	7.98	3.3	39	3000	10	4	"
49					8	32	20	12700	71	29	8.03	4.4	58	700	1	3	"
50		11.40 A		EBB	12	1	21	12300	68	32	7.94	2.6	38	7800	100	12	"
51					12	37	21	12700	70	30	7.93	2.4	30	1100	100	11	"
52		11.51 A		EBB	13	1	21	12300	68	32	7.94	2.6	33	8300	1000		
53					13	62	21	12200	68	32	7.95	2.4	30	1200	100		

Paul R. Phelps

Phelps

RESULT OF EXAMINATION OF NEW YORK HARBOR WATERS
JULY-1919

SAMPLE NO.	DATE JULY	TIME	HIGH WATER GOV'S I.D. * U.S. TIDE TABLES	TIDAL CURRENT	STATION	DEPTH FT.	TEMP. C.	CHLORINE P.P.M.	SEA WATER %	LAND WATER %	DISSOLVED OXYGEN			BACTERIA PER C.C.		REMARKS	
											SAT. VALUE P.P.M.	FOUND P.P.M.	PER CENT SATURATION	AT 20° C	B. COLI		
55	14	10:02 A	8.43 A	FLOOD	12	1	21	12100	67	33	7.96	2.3	29	2000	10		
56					12	54	20	12800	71	29	7.97	3.2	40	900	1		
57		10:12 A		FLOOD	13	1	20	12600	70	30	7.99	2.5	31	1800	10		
58					13	44	20	12600	70	30	7.99	3.1	39	1500	10		
59		10:38 A		FLOOD	6	1	21	12200	68	32	7.95	3.0	38	2300	10		
60					6	32	20	12600	70	30	8.07	3.7	46	1400	10		
61		10:58 A		FLOOD	7	1	21	12300	68	32	7.96	2.6	33	1700	0		
62					7	46	20	13300	75	25	7.99	3.9	49	700	1		
63		11:02 A		FLOOD	8	1	20	12600	70	30	7.99	3.2	41	1000	10		
64					8	55	19	13100	73	27	8.10	4.2	52	1300	10		
65		12:03 P		FLOOD	14	1	19	14000	78	22	8.10	4.9	60	1100	10		
66					14	64	18	14400	80	20	8.14	5.3	65	1000	1		
67		12:35 P		EBB	15	1	20	13600	76	24	7.98	5.4	68	1000	10		
68					15	80	18	15300	85	15	8.14	5.6	69	1700	1		
69		12:49 P		EBB	16	1	20	13500	75	25	7.98	5.3	66	2000	100		
70					16	80	18	15000	83	17	8.08	5.6	69	2100	1		
71	15	9:30 A	9.19 A	FLOOD	6	1	20	12300	68	32	8.01	2.3	29	2200	10		
72					6	45	20	12900	72	28	8.05	3.0	37		100		
73		9:35 A		FLOOD MID DEPTH	7	1	20	11800	66	34	8.07	2.6	32	1700	100		
74					7	44	20	12600	70	30	8.07	2.4	30	900	10		
75		9:45 A		FLOOD	8	1	21	12100	67	33	7.96	2.4	30	1000	100		
76					8	38	20	13000	72	28	8.03	2.6	32	700	1		
77		10:05 A		FLOOD	12	1	20	12600	70	30	7.99	2.3	29	1300	100		
78					12	53	20	13100	73	27	8.03	2.6	32	900	100		
79		10:18 A		FLOOD	13	1	20	13000	72	28	7.95	2.5	31	2100	100		
80					13	46	20	13200	73	27	8.02	2.7	34	800	10		
81		10:42 A		FLOOD	10	1	20	13000	72	28	7.95	2.0	25	2500	100		
82					10	35	20	12600	70	30	8.07	2.1	26	500	10		
83		10:55 A		FLOOD	9	1	20	13000	72	28	7.95	1.9	24	1300	100		
84					9	40	20	12600	70	30	8.07	2.5	31	500	10		
85		11:10 A		FLOOD	11	1	20	12800	71	29	7.97	2.0	25	3200	100		
86					11	35	20	13000	72	28	8.04	2.0	25	600	10		
87	16	9:24 A	9.56 A	FLOOD	12	1	20	12700	71	29	7.98	2.0	25	1900	10		
88					12	47	20	12800	71	29	7.97	2.1	26	400	10		
89		9:34 A		FLOOD	13	1	21	12000	67	33	7.96	2.2	28	2300	100		
90					13	44	21	12800	71	29	7.90	1.9	24	1200	100		
91		9:59 A		FLOOD	6	1	21	11900	66	34	7.97	2.4	30	4700	1000		
92					6	34	20	12600	70	30	7.99	3.1	39	300	10		
93		10:08 A		FLOOD	7	1	21	12000	67	33	7.96	2.5	31	4300	100		
94					7	40	20	12700	71	29	7.98	2.9	36	400	10		
95		10:19 A		FLOOD	8	1	21	12000	67	33	7.96	2.5	31	1100	10		
96					8	31	20	12600	70	30	7.99	2.8	35	500	10		
97		11:26 A		FLOOD	3	1	22	8500	47	53	8.12	3.4	42	17700	100		
98					3	49	22	9900	55	45	8.00	1.6	20	1300	100		
99		11:53 A		FLOOD	2	1	22	8100	45	55	8.15	3.1	38	12400	100		
100					2	58	22	9100	51	49	8.07	2.3	29	2700	10		
101		12:45 P		FLOOD	1	1	22	7900	44	56	8.17	3.1	38	6600	100		
102					1	40	22	9000	50	50	8.07	2.0	25	1500	10		

Earle B. Phelps

Phelps

RESULT OF EXAMINATION OF NEW YORK HARBOR WATERS
JULY-1919

SAMPLE NO.	DATE JULY	TIME	HIGH WATER GOVT I.D. & U.S. TIDE TABLES	TIDAL CURRENT	STATION	DEPTH FT.	TEMP C.	CHLORINE P.P.M.	SEA WATER %	LAND WATER %	DISSOLVED OXYGEN SAT. VALUE P.P.M.	DISSOLVED OXYGEN FOUND P.P.M.	DISSOLVED OXYGEN PER CENT SATURATION	BACTERIA PER C.C. AT 20°C.	BACTERIA PER C.C. B. COLI	REMARKS
103	17	9.15A	10.36 A	FLOOD	12	1	20.5	12100	67	33	8.03	1.4	17	3800	10	
104					12	44	20.0	12500	69	31	8.08	1.9	24	1200	10	
135		9.30 A		"	13	1	21.0	11600	64	36	8.00	2.1	26	5300	100	
136		9			13	47	20.5	12700	71	29	7.98	2.9	36	3000	100	
107		9.35 A		"	6	1	21.0	10500	58	42	8.10	2.1	26	4100	10	
108					6	34	20.5	11900	66	34	8.05	2.3	29	1600	10	
109		10.05 A		"	7	1	21.0	10800	60	40	8.07	2.3	29	5400	100	
110					7	44	20.5	12100	67	33	8.04	2.3	29	2300	10	
111		10.15 A		"	8	1	21.0	11000	61	39	8.05	2.0	25	4300	10	
112					8	30	20.0	12500	69	31	8.08	2.3	28	700	10	
113		10.55 A		"	14	1	20.0	13000	72	28	8.03	2.7	34	3500	10	
114					14	60	19.5	14100	78	22	8.01	4.1	51	800	10	
115		11.40 A		"	15	1	21.0	14100	78	22	7.94	3.7	47	2100	100	
116					15	75	19.0	14400	80	20	8.06	4.6	57	300	10	
117		11.55 A		SLACK	16	1	20.0	14300	81	19	7.90	3.7	47	3600	10	
118					16	80	19.0	14800	82	18	8.03	4.7	59	1400	1	
119	18	9.15 A	11.31 A	FLOOD	12	1	20.5	12300	68	32	8.02	1.9	17	4900	10	
120					12	47	20.0	13000	72	28	8.03	1.0	12	1100	100	Odor "Distinct Sewage"
121		9.25 A		"	13	1	21.0	12100	67	33	7.96	1.5	19	3900	100	
122					13	42	20.5	12700	71	29	7.91	0.8	10	900	10	" " "
123		9.45 A		"	6	1	21.0	10500	58	42	8.10	1.7	21	5300	100	
124					6	32	21.0	11700	65	35	7.99	2.0	25	600	100	
125		9.55 A		"	7	1	21.5	10200	57	43	8.05	1.9	24	6600	100	
126					7	35	21.0	12100	67	33	7.96	2.2	28	700	10	
127		10.05 A		"	8	1	21.5	10200	68	32	8.05	2.0	25	1900	100	
128					8	45	20.5	12500	69	31	8.00	2.2	28	900	10	
129		10.50 A		"	4	1	21.5	9200	51	49	8.13	2.0	25	7100	100	
130					4	40	21.0	10600	59	41	8.09	1.9	24	1000	10	
131		11.45 A		"	3	1	22.0	7100	39	61	8.23	3.5	43	13000	100	
132					3	32	21.0	8100	45	55	8.31	2.1	28	12000	100	
133		12.15 A		"	1	1	21.5	6200	34	66	8.39	4.6	55	11800	100	
134					1	32	22.0	7800	43	57	8.17	3.0	37	1400	10	
135	19	8.20 A	12.12 P	SLACK	6	1	21.0	10600	59	41	8.09	1.6	20	11500	1000	
136					6	40	21.0	12000	67	33	7.96	2.1	26	4600	10	
137		9.30 A		"	7	1	21.5	10400	58	42	8.03	1.8	22	4000	1000	
138					7	42	21.0	11600	69	31	8.00	2.2	27	2100	100	
139		9.45 A		"	8	1	21.8	10100	56	44	8.06	1.6	20	7000	1000	
140					8	30	21.0	11400	68	32	8.02	1.5	19	1900	10	
141		10.00 A		FLOOD	12	1	21.0	12000	67	33	7.96	1.4	18	8400	10	
142					12	39	21.6	12700	71	29	7.84	0.5	6	3800	10	
143		10.15 A		"	13	1	21.5	12100	67	33	7.89	1.3	16	10400	1000	
144					13	40	20.5	12800	71	29	7.97	1.0	13	2900	100	
145	22	9.27 A	9.30 P	LOB	12	1	21.0	12800	71	29	7.90	1.4	18	5500	10	Odor "Strong Musty"
146		9.37 A			12	46	21.0	13000	72	28	7.88	1.4	18	1800	100	
147		9.47 A		"	13	1	21.0	12800	71	29	7.90	1.1	14	6900	1000	" " "
148					13	35	21.5	12800	71	29	7.83	1.2	15	3000	10	
149		10.06 A		"	6	1	21.5	11500	64	36	7.94	2.6	33	6400	100	
150					6	28	21.8	12200	68	32	7.91	2.1	27	1000	10	
151		10.16 A		"	7	1	21.6	11300	63	37	7.96	2.6	33	6000	100	
152					7	35	21.8	12100	67	33	7.82	2.1	27	2500	10	
153		10.28 A		"	8	1	22.0	11700	65	35	7.85	2.2	28	4500	100	
154					8	45	21.5	12500	69	31	7.85	1.9	24	800	10	
155		12.30 A		"	17	1	23.8	6500	36	64	8.00	0.9	11			" " "
156		12.16 A		"	18	1	24.0	5000	28	72	8.12	0.45	6			" Strong Sewage"
157		12.50 A		"	19	1	23.0	1700	9	91	8.65	0.4	5			" Strong Offensive
158		1.30 P		"	17	1	23.1	7700	43	57	7.97	0.9	11			

Earle B. Phelps

Standard Time 75th Meridian

SHEET NO-4

Phelps

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RESULT OF EXAMINATION OF NEW YORK HARBOR WATERS
JULY-1919

SAMPLE NO.	DATE JULY	TIME	HIGH WATER GOV'S I'D & U.S. TIDE TABLES	TIDAL CURRENT	STATION	DEPTH FT	TEMP. C.	CHLORINE P.P.M.	SEA WATER %	LAND WATER %	DISSOLVED OXYGEN SAT. VALUE P.P.M.	DISSOLVED OXYGEN FOUND P.P.M.	DISSOLVED OXYGEN PER CENT SATURATION	BACTERIA PER C.C. AT 20° C.	BACTERIA PER C.C. B. COLI	REMARKS
159	23	9.30 A	4 42 P	EBB	12	1	21	12400	69	31	7.86	1.3	17	6900	100	
160					12	42	21	12600	70	30	7.92	1.7	22	4800	10	
161		9.45 A		"	13	1	22	12500	69	31	7.78	1.2	15	19400	100	
162					13	40	21	12800	70	30	7.85	1.2	15	4700	100	
163		10.05 A		"	6	1	21	11000	61	39	7.98	1.4	18	7700	100	
164					6	32	21	12100	67	33	7.96	1.9	24	3500	10	
165		10.15 A		"	7	1	21	10900	61	39	7.99	2.7	34	12500	10	
166					7	42	21	12700	71	29	7.91	2.2	28	3400	10	
167		10.30 A		"	8	1	21	11000	61	39	7.98	2.0	25	11400	100	
168					8	45	21	12800	71	29	7.90	2.5	32	2000	10	
169		11.00 A		"	14	1	21	11500	64	36	7.94	2.2	28	7000	100	
170					14	35	21	13500	75	25	7.84	2.8	36	2800	10	
171		11.25 A			15	1	21	12800	71	29	7.83	2.3	29	3500	100	
172					15	30	21	13500	75	25	7.84	3.1	40	2700	10	
173		11.35 A			16	1	21	12500	69	31	7.92	2.5	32	8400	100	
174					16	30	21	14100	78	22	7.79	3.7	48	1100	1	
175	24	9.25 A	5 14 A	FLOOD	6	1	22	11500	64	36	7.87	2.0	25	3000	100	
176					6	45	21	12500	69	31	7.85	2.7	34	2200	10	
177		9.35 A		SLACK	7	1	22	11500	64	36	7.87	1.8	23	3400	1000	
178					7	40	21	13200	68	32	7.88	2.5	32	1100	100	
179		9.45 A		SLACK	8	1	22	11400	63	37	7.87	1.9	24	3400	100	
180					8	30	21	12500	69	31	7.85	2.2	28	3600	10	
181		10.10 A		EBB	12	1	22	11700	65	35	7.85	1.1	14	5000	1000	
182					12	40	21	11700	65	35	7.92	1.3	16	7000	100	
183		10.20 A		"	13	1	21	11800	66	34	7.92	0.6	8	5800	100	
184					13	40	21	11700	65	35	7.92	0.7	9	1000	10	
185		11.00 A		"	10	1	21	11900	66	34	7.91	0.4	5	8900	100	
186					10	35	21	12000	67	33	7.90	0.3	4	2400	100	
187		11.20 A		"	9	1	21	12100	67	33	7.96	0.5	6	4500	100	
188					9	40	21	12600	70	30	7.92	1.5	19	5600	100	
189		11.35 A		"	11	1	21	12200	68	32	7.95	0.5	6	5200	100	
190					11	25	21	12300	68	32	7.94	0.4	5	2900	10	

Earle B. Phelps

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RESULT OF EXAMINATION OF NEW YORK HARBOR WATERS
JULY-1919

SAMPLE NO.	DATE JULY	TIME	HIGH WATER GOV'S ID # U.S. TIDE TABLES	TIDAL CURRENT	STATION	DEPTH FT.	TEMP C.	CHLORINE P.P.M.	SEA WATER %	LAND WATER %	DISSOLVED OXYGEN SAT. VALUE P.P.M.	DISSOLVED OXYGEN FOUND P.P.M.	DISSOLVED OXYGEN PER CENT SATURATION	BACTERIA PER C.C. AT 20° C.	BACTERIA PER C.C. B. COLI	REMARKS
191	25	9.25 A	6:19 A	EBB	12	1	21	11800	64	34	7.92	14	18	4600	100	
192					12	45	22	12000	67	33	7.82	14	18	4300	10	
193		9.50 A		"	13	1	21	12200	68	32	7.88	12	15	5300	100	
194					13	40	21	12100	67	33	7.89	14	18	1900	1	
195		10.10 A		"	6	1	21	11900	66	34	7.91	23	28	2000	100	
196					6	50	21	12200	68	32	7.88	31	39	1300	10	
197		10.20 A		"	7	1	21	11500	64	36	7.94	22	28	3400	100	
198					7	45	21	13900	72	28	7.90	31	39	1200	1	
199		10.30 A		"	8	1	22	11000	61	39	7.91	21	27	6000	100	
200					8	30	21	12000	67	33	7.90	24	30	1400	1	
201		12.45 P		"	3	1	23	6600	37	63	8.13	16	45	2600	10	
202					3	15	23	6000	37	63	8.13	25	31	1100	10	
203		1.00 P		"	3	1	23	6500	36	64	8.14	40	49	6400	100	
204					3	30	22	7500	42	58	8.13	21	26	2100	10	
205		1.45 P		"	1	1	23	5000	28	72	8.20	51	62	5100	100	
206					1	30	23	6300	36	64	8.14	29	36	2500	100	
207		2.01 P		"	1	1	23	5000	28	72	8.20	56	68	12200	10	
208					1	20	23	6000	33	67	8.18	36	44	4900	100	
209	26	9.20 A	7:17 A	FLOOD	6	1	22	11200	62	38	7.90	22	28	7000	100	
210					6	30	21	12300	69	31	7.85	29	37	1900	10	
211		9.25 A		"	7	1	22	11500	64	36	7.87	21	27	4500	100	
212					7	45	21	12700	71	29	7.91	34	43	1300	10	
213		9.35 A		"	8	1	22	11100	62	38	7.90	23	29	6600	10	
214					8	30	21	12700	71	29	7.91	33	42	1200	10	
215		9.55 A		"	12	1	22	11600	65	35	7.86	19	24	6300	100	
216					12	40	21	12100	67	33	7.96	25	31	2000	10	
217		10.45 A		SLACK	13	1	23	11700	65	35	7.85	21	27	4400	10	
218					13	35	21	12100	67	33	7.90	26	33	900	1	
219		10.40 A		EBB	10	1	22	11800	64	36	7.87	18	23	4000	10	
220					10	40	23	11600	65	35	7.86	14	23	1600	10	
221		11.00 A		"	9	1	22	11100	62	38	7.90	11	14	12600	100	
222					9	30	22	11800	64	36	7.87	12	15	3300	1	
223		11.15 A		"	11	1	22	11400	63	37	7.88	10	13	3400	100	
224					11	35	22	11500	64	36	7.87	16	20	1100	10	
225	26	9.30 A	8:01 A	FLOOD	12	1	23	11400	63	37	7.75	18	23	4300	1000	
226					12	40	22	11800	64	36	7.80	18	23	1500	10	
227		9.40 A		"	13	1	23	11100	62	38	7.75	19	25	12200	100	
228					13	40	22	11500	64	36	7.80	19	24	800	10	
229		10.10 A		"	6	1	22	11000	61	39	7.84	20	27	4100	10	
230					6	28	22	11800	66	34	7.84	22	28	1200	10	
231		10.20 A		"	7	1	23	11500	64	36	7.86	24	31	2900	100	
232					7	40	21	12400	69	31	7.86	31	40	2200	10	
233		10.30 A		"	8	1	23	12000	67	33	7.66	25	33	3400	10	
234					8	50	22	12800	69	31	7.79	32	41	1500	10	
235		11.10 A		"	14	1	22	13000	72	28	7.74	40	52	4100	100	
236					14	50	21	14000	78	22	7.80	51	65	1000	10	
237		11.45 A		SLACK	15	1	22	13000	72	28	7.74	46	59	3800	10	
238					15	80	21	14500	81	19	7.75	53	68	1600	1	
239		11.55 A		"	16	1	21	13800	77	23	7.76	50	65	10300	10	
240					16	80	21	14600	81	19	7.74	51	66	2700	1	

Earle B. Phelps

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RESULT OF EXAMINATION OF NEW YORK HARBOR WATERS
JULY - 1919

SAMPLE NO.	DATE JULY	TIME	HIGH WATER, GOV'S I.D. N U.S. TIDE TABLES	TIDAL CURRENT	STATION	DEPTH FT	TEMP C	CHLORINE P.P.M.	SEA WATER %	LAND WATER %	DISSOLVED OXYGEN			BACTERIA PER C.C.		REMARKS	
											SAT. VALUE P.P.M.	FOUND P.P.M.	PER CENT SATURATION	AT 20°C.	B. COLI		
241	29	8:10 A	9:48 A	Flood	12	1	22	10800	60	40	7.85	1.9	24	7200	100		
242					12	99	22	11100	62	38	7.90	2.0	25	2500	100		
243		8:30 A		"	13	1	22	10400	58	42	7.89	2.1	26	7800	100		
244					13	40	22	11000	61	39	7.90	2.0	25	3500	10		
245		9:45 A		"	6	1	22	10700	59	41	7.86	2.9	36	11200	100		
246					6	30	22	11100	62	38	7.90	2.2	28	4200	100		
247		9:55 A		"	7	1	22	10800	58	42	7.95	2.7	34	6600	100		
248					7	45	22	11100	64	36	7.87	2.0	25	3500	10		
249		10:00 A		"	8	1	22	10700	59	41	7.93	2.4	30	9200	1000		
250					8	40	21	11400	65	35	7.93	2.3	29	2200	10		
251		11:15 A		"	3	1	23	6700	37	63	8.05	3.5	44	5700	1000		
252					3	40	23	7600	37	63	8.05	1.9	23	3500	100		
253		11:25 A		"	3	1	23	6900	38	62	8.04	2.6	32	7000	100		
254					3	28	23	7300	41	59	8.07	1.8	22	1400	1		
255		11:30 A		"	1	1	24	6400	33	67	8.05	3.1	39	8800	100		
256					1	25	23	6700	36	62	8.10	2.0	25	8200	10		
257		12:00 P		"	1	1	23	6100	34	66	8.10	3.2	40	6000	100		
258					1	40	23	6700	37	63	8.12	2.1	26	800	1		
259	30	9:25 A	10:33 A	"	6	1	22	10400	56	44	7.98	2.1	26	3400	100		
260					6	36	21	11400	63	37	7.95	2.2	28	1200	100		
261		9:35 A		"	7	1	22	9200	51	49	8.04	2.6	33	5600	100		
262					7	30	21	11000	62	38	7.98	2.5	31	800	100		
263		9:40 A		"	8	1	22	9100	51	49	8.07	2.5	31	3100	100		
264					8	30	21	10600	59	41	8.02	2.4	30	1600	100		
265		10:00 A		"	12	1	22	10100	56	44	7.99	2.3	29	3800	100		
266					12	40	21	11100	62	38	7.98	2.0	25	1000	10		
267		10:10 A		"	13	1	22	10600	59	41	7.95	2.2	28	4500	100		
268					13	40	21	11100	62	38	7.92	2.4	30	700	100		
269		10:30 A		"	10	1	22	11100	62	38	7.90	1.8	23	3700	1000		
270					10	35	22	11200	62	38	7.94	2.1	27	2500	100		
271		10:45 A		"	9	1	22	11200	62	38	7.90	1.6	20	6500	100		
272					9	45	21	11200	62	38	7.97	2.0	25	2300	100		
273		11:00 A		"	11	1	22	11100	62	38	7.90	2.0	25	7100	100		
274					11	40	21	11200	62	38	7.97	2.3	29	1700	1		
275	31	9:20 A	11:18 A	"	12	1	22	10100	61	39	7.94	1.9	24	2700	100		
276					12	40	21	11700	65	35	8.01	2.5	31	900	100		
277		9:30 A		"	13	1	22	10600	59	41	7.96	2.2	28	1700	100		
278					13	40	22	11300	63	37	7.88	2.2	28	500	100		
279		9:50 A		"	6	1	23	9200	51	49	7.91	2.0	25	2900	100		
280					6	30	22	10000	56	44	8.00	2.4	30	400	100		
281		10:00 A		"	7	1	22	9400	52	48	7.97	2.7	34	1700	10		
282					7	40	22	10400	58	42	7.96	2.5	31	300	1		
283		10:10 A		"	8	1	22	9900	55	45	7.93	2.2	28	1900	10		
284					8	45	21	11000	61	39	8.05	3.1	38	1200	1		
285		10:50 A		"	14	1	22	11800	66	34	7.94	3.0	38	3400	100		
286					14	60	20	13000	72	28	8.04	4.7	59	1000	10		
287		11:35 A		"	15	1	21	13000	72	28	7.88	4.1	51	1800	100		
288					15	80	19	13500	75	25	8.15	5.1	63	2100	10		
289		11:25		"	16	1	20	13500	75	25	7.99	4.6	58	1700	10		
290					16	80	19	14000	78	22	8.02	5.3	66	600	10		

Earle B. Phelps

Sheet 7

RESULTS OF EXAMINATIONS OF

NEW YORK HARBOR

WATERS
[illegible]
1919

Description of Sampling Stations

Station No. 1	Hudson River,	Spuyten Duyvil,	Mid-stream		
2	"	"	Dykeman Street,	"	"
3	"	"	135 th	"	"
4	"	"	42 nd	"	1/3 way N.Y to N.J.
5	"	"	"	"	2/3 " " " "
6	"	"	Pier A.		1/4 " " " "
7	"	"	" "		1/2 " " " "
8	"	"	" "		3/4 " " " "
9	East	"	42 nd	"	Middle of west channel
10	"	"	23 rd	"	1/3 way N.Y. to Brooklin
11	"	"	"	"	2/3 " " " "
12	"	"	Pier 10.		1/3 " " " "
13	"	"	" "		2/3 " " " "
14	Ship Channel east of Robbin's Reef				
15	Narrows,	1/3 way Staten Island to Brooklin			
16	"	2/3 " " " " "			
17	Newark Bay, off Centerville Light				
18	"	"	Lehigh Valley N.R. bridge		
19	"	"	Central Railroad Bridge, (Newark Branch)		

Carl B. Phelps.

A. Yes, this one identifies the stations.

Q. Sheet No. 7, Professor, is a description of the location of 19 stations.

A. Perhaps I can help you, Mr. Riker. These last three stations appear only once, that is, at the bottom of sheet No. 3.

Q. Were you present at the taking of any samples at stations 17, 18 and 19?

A. Yes, sir. That helps me to identify another day. I was present on the 22nd of July, and saw the taking of all of those samples on that date.

Mr. Riker: The introduction of this testimony, orally, or by way of tables, is objected to, on the ground that it does not appear that it is sufficiently proved by this witness, or to conform to any
856 facts within his knowledge.

The Commissioner: Note the objection of counsel for the defendants.

The tables are as follows:

(Here follow tables marked pages 857 to 863, inclusive).

864 By Dr. O'Sullivan:

Q. Prof. Phelps, you stated earlier in your testimony that during the first week in July you organized a party to work under your supervision. You mentioned some names, among which was that of Mr. W. T. Carpenter, Chemist. Who is Mr. Carpenter? State how long you have known him and what you know of his qualifications, and what official position he holds.

A. I have known Mr. Carpenter for at least ten years. First, as graduate student at the Institute of Technology.

Q. The Massachusetts Institute of Technology?

A. The Massachusetts Institute of Technology and later, in his professional capacity. Mr. Carpenter was in my employ at the time of the investigation made by Col. Black and myself in New York Harbor, and took an active part in the chemical work of that investigation. He has since been in various employ, and is now in the employ of the City of New York, under Mr. Allen's department. I can not give you his exact title, and he has been engaged for several years in the continuation of the dissolved oxygen studies that Mr. Allen has been making.

Q. Is he now retained by the Board of Estimate and Apportionment of the City of New York?

A. I understand that that is his capacity. I am not certain of the title.

Q. What do you know of his efficiency and reliability, as a
865 chemist?

A. He is a man of the most excellent and thorough training, and one in whose efficiency and integrity I have the highest confidence.

Q. Now, as to the second gentleman you mentioned as among the party that you organized in the first week of July, Mr. P. A. Frost, Biologist; what do you know of Mr. Frost?

A. Mr. Frost was recommended to me by my former business associate, Dr. Charles E. North, of this city, and aside from Dr. North's recommendations, I know almost nothing from his qualifications. I am satisfied, however, that he is qualified, having personally watched more of his work than that of Mr. Carpenter, because it was done ashore, and much more thoroughly and completely checked all of his results. I feel that I have had a personal touch over the biological work, much closer than that over the chemical work.

Q. Who is the third member, Mr. A. S. Bonney, Bacteriologist?

A. Mr. Bonney, the Bacteriologist, was also supplied to me by Dr. North, from his laboratory force, and is a man whom I have known for some seven years. He has been Dr. North's chief bacteriologist during the greater part of that time, and he is a man in whom I have every confidence, and who is thoroughly able and competent to do this sort of work.

Q. The fourth and fifth members, Mr. John McManus, Hydrographer, and Mr. Harry Lehnpuhl, Hydrographer? Did they
866 do the mechanical work of procuring samples?

A. Yes, sir. These men were furnished to me by the Dock

Department of this City, in response to a request for men who were competent hydrographers, and who had experience in making deep water soundings. Both of these men were reported to me as being thoroughly familiar with the New York harbor waters and bottoms, and Mr. McManus, in particular, having had 18 years' experience in soundings of this Bay.

Q. Now, as to Mr. Patrick McDonough, who took the place of Mr. McManus, towards the latter part of these examinations, did you find him competent?

A. He was also recommended to me and furnished by the Dock Department, and although not having had so long an experience as Mr. McManus, was a competent man, and apparently well familiar with the art of making deep water soundings, and performed his duties in a very satisfactory manner.

Q. And these three men, did they perform the mechanical function of securing samples?

A. That, and the rather delicate operation of determining the bottom depth, and determining when the sample apparatus had struck bottom.

Q. Now, Prof. Phelps, how long does your knowledge extend directly over the conditions in New York Harbor, through investigations and examinations and analyses of our harbor waters?

A. I was in 1908 or 1909, in rather close contact in consultation with Dr. Soper, in connection with his investigations of the
867 Harbor. My first actual contact of a personal nature was in 1910, when Col. Black and I made our investigation extending over a year; and then I followed with the closest attention the subsequent work of the Metropolitan Sewerage Commission, and have recently taken occasion to review all of this work in great thoroughness, and to make a detailed analysis and study of all the available data from 1907 to the present date.

Q. Apart from the analytic work which you did towards oxygen determinations during the twelve months of 1910, and the studies that you have made of the various oxygen exhibits in this case, and the work that you are now testifying to as to the oxygen determinations that you made during the month of July, have you made other oxygen determinations that are already a part of the record in this case, in conjunction with Prof. William T. Mason, and other chemists?

A. I do not recall that I have, sir.

Q. Prof. Phelps, have you made a comparative study of the various exhibits already in evidence in this case, as to the oxygen determinations, and of your own recent work in oxygen and bacteriology, and have you tabulated these results?

A. I have made a comparative study of these data and of those of earlier years that are already a matter of record in this case, namely:

(a) The results of the Metropolitan Sewerage Commission,
868 which is found in the published reports of that Commission of 1912 and 1914.

(*b*) The work of the Sewer Plan Commission, and later of the Bureau of Public Improvements, introduced in the record during the present hearing by Mr. Allen.

Q. Now, will you state as to how these comparative studies and tabulations compare with the harbor conditions as described by Mr. Whipple?

Mr. Riker: One moment. I object to the question as based on material which has not been properly proved, and therefore is not a fit basis for comparison; also on the ground that the answer called for is not an expert opinion, but an argument from this witness as to the results.

The Commissioner: Note the objection of counsel for the defendants.

A. Mr. Whipple stated it as his judgment, (stenographic minutes page 395), that a satisfactory comparison of harbor conditions from year to year would necessitate "a collection and analysis of a considerable number of samples, collected on different days, at different stages of the tide, and extending over a considerable interval of time." These conditions are fortunately met in the large mass of data available in this case, so that it is unnecessary, as well as misleading, to attempt to generalize from a few scattered analyses.

I have selected for my study a total of about 2,814 dissolved
869 oxygen results. These include all the available data upon four important areas, during the months June to September inclusive, and the years 1909 to 1919 inclusive, except the year 1910 for which no data are available. The study has been limited to four selected areas: first, because the most continuous and extensive work has been done upon these areas by all investigators; and, secondly, to limit the work of computation. It has been limited to the warm weather months, because the problem is essentially a warm weather problem.

I have, however, included for comparison Prof. Whipple's results of November 3rd and 4th, 1909, and May 3rd, 1919.

The selected areas are:

(*a*) The Narrows, or mouth of the Upper Bay; through which nearly the whole of the tidal prism of the harbor passes one or more times.

(*b*) The vicinity of Robbins Reef; representative of the Upper Bay.

(*c*) The East River from Hell Gate to the Battery.

(*d*) The Hudson from Spuyten Duyvil to the Battery.

I have averaged all the samples of each area for the season, regardless of the condition of the tide or source of the sample as to depth.

Other methods of analysis would yield more detailed infor-
870 mation, but for the purpose of a study of the general condition of the waters and its change from year to year, such a general average is most reliable.

The results of this study are tabulated for more ready reference. The table shows the name of the investigator, the number of samples upon which the average is based, and the average value of the dissolved oxygen in per cent of saturation for each of the four areas and for each of eleven years, except 1910, for which no data are available.

Q. Have you got those tables?

A. Yes, these are the tables.

Mr. Riker: Prof. Phelps, in making up this table, in the first place did you make it up yourself?

The Witness: Yes, sir.

By Mr. Riker:

Q. And in making up the table, what did you use?

A. What data? The table includes Prof. Whipple's results of November 4th and 5th, 1909, on the first line. The results obtained by the Metropolitan Sewerage Commission for the years 1909, 1911, 1912 and 1913; and the results obtained by New York City, either by the Bureau of Sewer Plan, or the Bureau of Public Improvement. That was begun by the one and ended by the other, for the years 1914, 1915, 1916, 1917 and 1918, then I have included
871 Prof. Whipple's results of May 3, 1919, and finally my own results of July, 1919. All of these results are in evidence.

Q. Can you state from your recollection on how many days the samples tabulated here for 1914, were taken?

A. I can, if you will allow me to refresh my memory (referring to papers). No, sir, I can not. I thought I had the original memoranda with me, but I have not.

Q. Do you not know they were reported to have been taken only on one day?

A. No, sir, I do not think that is the case.

Q. Why did you in that case put it June to September?

A. Because the purpose of these limits is to show the results taken during that period, excluding all the winter results, in many years' work.

Q. But in the case of Prof. Whipple's sampling, you gave the date May 3rd?

A. That was a single day.

Q. In 1915, how many days were purported to have been occupied in taking the sixteen samples?

A. I can not tell.

Q. Do you know there was only one day in that year?

A. I am quite certain that there were more in that year, because I see 83 samples from the East River, and it would have been an impossibility to take 83 samples in one day.

Q. How many days in 1916 were purported to have been covered by the sampling?

A. I can not say, Mr. Riker.

Q. In 1918, how manys days?

872 A. That does not appear in the record, either.

Q. Is it not important for the purposes of comparison, to know the dates of these samplings?

A. It is, within a certain range. It is not important to know the exact date. If, for example, it is known that they are summer samples and there are a fair number of them, it does not matter so much whether they were taken in July or August, within ten days, or twenty days.

Q. It does not make any difference whether they were taken in July or August or September?

A. No, sir, not much.

Q. Does it make any difference whether they were taken in August or June?

A. I would expect the August results to be a little lower than the June results.

Q. Did you have in the exhibit you used for the purpose of making up this table, the determinations of samples taken in May?

A. Only those taken by Mr. Whipple in May of this year.

Q. There were none taken in May in any other year covered by this?

A. There were plenty of samples taken in May, yes, but these were excluded.

Q. Why did not you use them?

A. I wanted to get the strictly summer conditions, the minimum conditions.

Q. You did not want to get conditions which would be comparable in determining the comparative results of Prof. Whipple and these other parties?

A. No, sir, I was not interested in that. The results were——

873 Q. Are you not called upon to testify as to the accuracy or inaccuracy as to the comparative results of Prof. Whipple and those other samplers?

A. I do not so understand it, no, sir.

Q. As a matter of fact, are the samples taken by you in July, a fair basis of comparison with the samples taken by Prof. Whipple in May?

A. They are a fair basis of comparison, but they must be used with the proper knowledge of how that comparison should be made.

Q. And in so far as the samples taken in 1909, 1911, 1912, 1913, 1914, 1915, 1916, 1917 and 1918 are concerned, are samples taken during the summer months comparable with those taken by the Professor in May, of this year?

A. It depends upon what you mean by "comparable," Mr. Riker. I can compare summer and winter samples, and draw a conclusion, so that the question is not definite as to a thing being fairly comparable.

Q. Is not the purpose of your comparison to show the inaccuracy of Prof. Whipple?

A. No, sir.

Q. What is it then?

New York Harbor – Dissolved Oxygen.

Summary of 2814 Examinations, 1909 - 1919

Investigator and Date of Investigation	Narrows		Robbins Reef		East River Battery to Hell Gate		Hudson River Battery to Spuyten Duyv.	
	No. of Samp.	% Sat.	No. of Samp.	% Sat.	No. of Samp.	% Sat.	No. of Samp.	% Sat.
Whipple 1909 Nov. 4-5	6	78	2	76	6	61	7	67
Nat. Sew. Com. 1909 Jun-July.	35	83	19	74	93	65	97	73
" " " 1911 July-Sept.	132	79	117	73	217	54	345	61
" " " 1912 Jun-Sept.	56	79	12	64	57	50	57	57
" " " 1913 Jun-Sept.	158	72	53	69	239	41	145	51
N.Y. City 1914 Jun-Sept.	16	68	2	71	96	40	94	50
" " " 1915 Jun-Sept.	16	79	4	72	83	33	76	42
" " " 1916 Jun-Sept.	16	64	6	64	44	26	54	46
" " " 1917 Jun-Sept.	24	63	6	50	54	30	44	39
" " " 1918 Jun-Sept.	6	68	4	56	6	21	8	54
Whipple 1919 May 3	6	76	2	83	5	66	3	68
Phelps 1919 July 7-15	8	68	4	63	32	34	42	50
" " July 15-31	16	53	8	45	70	20	106	31
" " July 7-31	24	58	12	51	102	24	148	36

Carle B. Dawson

A. It is to show the true character of the harbor with the progress of time.

Q. Why did you put in Prof. Whipple's analyses at all, then?

A. Merely because they were in evidence, and I want to draw some conclusions concerning it, later.

Q. And you said there were a large number of samples in
874 evidence taken in the month of May of different years?

A. Yes, sir, a great many.

Q. Why did not you put those in for the purpose of showing the conditions in the harbor, in the month of May?

A. I did not care to show the conditions in the month of May.

Q. You did not care to put into this record, any fair basis of comparison between the work alleged to have been done by others, and that done by Prof. Whipple, is that it?

A. I cared to put into the record the most fair basis of comparison that I had within my knowledge as to the actual condition of this harbor during the summer.

Q. A comparison with the results obtained by Prof. Whipple?

A. Prof. Whipple's results have no interest to me in this comparison. They are not representative of the summer conditions.

Q. Why did you put them in, then?

A. I have previously answered that question.

Q. Answer it again.

A. I am making some comparisons of these results with some of my own, which show the reason why they are higher than some of ours. In that sense I propose to compare them.

Q. If you were going to make the comparisons which would be fair and reasonably accurate, would not you take the same conditions of other samples?

A. No, sir, because the comparison I propose to make is
875 one of seasonal variation, and I purposely select samples taken in July for comparison with his May results.

Q. Why did not you use samples taken in the month of May in previous years, that is, records in May?

A. Because that would not disclose the seasonal variation.

Q. It would disclose, however, the variations in conditions under the same conditions practically in the same month would it not?

A. It might, or it might not. I was not interested in that point.

Mr. Riker: The table proposed to be placed in the record is objected to on the ground that it is based upon statements which have not been sufficiently verified, and not proved in the case, and a basis upon which to form the tabulation of the results proposed to be contained in this statement.

The Commissioner: Note the objection of counsel for the defendants.

(The paper is as follows:)

(Here follows table marked page 876.)

877 By Dr. O'Sullivan:

Q. Professor Phelps, this summary of your 2,814 examinations——

Mr. McCarter: His examinations?

Q. Between the years 1909 and 1919; is that summary based on oxygen tabulations and determinations already in evidence in this case?

A. Yes, sir.

Mr. Riker: One moment. I move to strike out the question and the answer, please, because I interposed. I put an objection to the question.

Dr. O'Sullivan: You do not strike the question out?

Mr. Riker: No, sir.

Dr. O'Sullivan: You said the question and the answer.

Mr. Riker: I said the answer, I think.

The Commissioner: Note the objection of counsel for the defendants.

Mr. Riker: The objection has not been put in form. I desired to put it into the record before the answer went in.

The Commissioner: Strike out the answer and what I said, and let Mr. Riker have the floor.

Mr. Riker: The question is objected to on the ground that it is not an accurate statement of the examinations that are referred to as being the examinations of this witness.

Dr. O'Sullivan: My question did not import any such imputation.

878 The Commisisoner: Note the objection of counsel for the defendants. Now you can put his answer in.

A. Yes, sir.

Q. Are sewage problems, winter or summer problems?

A. The worst effects of pollution in waters by sewage, occur in the hot weather season. That is the time when streams break down and the greatest nuisances appear, and in the case of streams which are being polluted by gradually increasing sewage load, from year to year, the nuisances appear first in the summer time.

Q. Is the bacterial content of waters, either sea water or land water, lower or higher in winter or in summer?

A. Higher in the summer.

Q. The content, the oxygen content is higher in the summer?

A. The bacterial content, your question asked for.

Q. Are the bacteria more active in summer or in winter in our harbor waters?

A. In summer.

Q. Has there been a late spring in 1919, or has it been an early spring?

A. My impression is that the spring has been an unusually late one.

Q. Has the precipitation been unusually heavy during the early part of the year 1919, in the Hudson River Basin?

A. Speaking merely from observation, it has.

Q. What would an unusually heavy precipitation in the months of March and April, and the early part of May, have as an
879 influence on the oxygen conditions of New York harbor waters?

Mr. Riker: The question is objected to as being based upon hypotheses, which have not been proved in this case—the precipitation in these months was unusually heavy.

The Commissioner: Note the objection of counsel for the defendants.

A. The effect would be an increase in the dissolved oxygen of the waters, particularly those of the rivers.

Q. Will that apply to the Hudson River?

A. Yes, sir.

Q. Has the precipitation been as high as almost seven inches, within eight eight days in the month of July, during which you have conducted your oxygen determinations in New York Harbor waters of this year? 't has, according to the Weather Bureau reports.

Q. What influence would that have on the oxygen content of the waters of New York Harbor?

A. That period of heavy rainfall actually was discernible, especially in our chlorine results of the last week in July. The oxygen was falling from day to day throughout the month of July, so that the effect of the precipitation was not noticeable in raising the oxygen content of the water at that time.

Q. Mr. Riker in his questions to you, implied that you did not choose any fair basis for comparison. What was your object
880 in making this summary that you are reading into the evidence, of the 2,814 examinations for oxygen, between 1909 and 1919?

Mr. Riker: The question is objected to as being counsel's interpretation of the questions asked by counsel for the defendants, and not referring to the actual questions themselves.

The Commissioner: Note the objection of counsel for the defendants.

A. The critical condition of the waters of New York Harbor occurs during the hot weather months. If one is studying limiting conditions, and comparing the intensity of those critical conditions from year to year, one naturally selects that hot weather period for such comparison. My whole purpose in making this table was to determine whether or not the dissolved oxygen in New York Harbor waters during the critical summer months was decreasing from year to year.

Q. And what did you find as the result of that study?

Mr. Riker: The question is objected to on the same ground as the objection to the summary table which was put in the record.

The Commissioner: Note the objection of counsel for the defendants.

A. In 1909, in November, Prof. Whipple examined six samples at the Narrows and found an average of 78% dissolved
881 oxygen.

Q. Is that shown in Defendants' Exhibit 9?

A. Yes, sir.

Q. You may proceed.

A. In the same year, but earlier in the season, June and July, the Metropolitan Sewerage Commission examined thirty-five samples, and found an average of 83 per cent. The results for the succeeding years are: 79, 79, 72, 68, 79, 64, 63, 68 and 58, the last result being my value for July of this year.

Similarly for the vicinity of Robbins Reef, Mr. Whipple found in 1909 (2 samples only) 76%; the Metropolitan Commission (19 samples) 74%; and then for the succeeding years: 73, 64, 69, 71, 72, 64, 50, 56, and 51.

A similar gradual but pronounced decline is shown in the oxygen values in the Hudson and East River.

Mr. Whipple's values for May 3, 1919, which I have not read in this reading are distinctly out of harmony with this series. This is readily explained if they be compared with my two sets of averages for the periods July 7-15 and July 16-31. At each station the three values, May 3, July 7-15 and July 16-31 form a rapidly descending series, showing the pronounced effect of the warm weather, an effect which is not only a temperature function but a cumulative one with the continuance of warm weather. For this reason, Mr. Whipple's May 3 values are not comparable with the other values of this table which are summer values.

882 Taking these three figures of the Narrows, for example, Mr. Whipple, on May 3rd found 76 per cent. I found, the second week of July, 68; and the last two weeks of July, 53. At Robbins Reef, the same three figures are 83, 63, 45, and in the East River, 66, 34, 20; and in the Hudson River, 68, 50, 31.

This comparison illustrates the extreme importance of season and temperature as affecting dissolved oxygen conditions of the waters, and the importance of securing adequate sampling, in order to bring out the true state of affairs during the critical season.

For the purpose of showing in a more comprehensive manner, the general effect of increasing pollution upon the harbor waters, I have prepared a table showing the oxygen depletion, or the differences between the values actually found and the normal or saturation values. An oxygen value of 80 per cent of saturation shows a depletion of 20 per cent. The depletion is a measure of the oxygen used up by the polluting organic matter, and consequently of the amount and character of pollution in the harbor.

I will read in the table——

By Mr. Riker:

Q. Your purpose is, Professor, to read into the record a table of oxygen depletion in New York Harbor, 1909 to 1919, is it not?

A. Yes, sir.

883 Q. Upon what data is this table made up?

A. That is based upon exactly the same data as the last table which I read into the record, which contains the same——

Q. Including the data for the years 1909 to 1913?

A. Yes, sir.

Q. Including the data of 1914, 1915, 1916, 1917 and 1918?

A. Yes, sir.

Q. What do you know about that data?

A. Nothing personally, except that it is in evidence here.

Q. You do not know whether it was properly approved or not?

A. No, sir, I do not know about that.

Q. You had nothing to do with the taking of it?

A. No, sir, I simply assumed that it was correct.

Q. And then 1919 is the data which you have offered here and which has been objected to?

A. Yes, sir.

Mr. Riker: The question is objected to as being based upon data which has not been proved in this case.

The Commissioner: Note the objection of counsel for the defendant.

By Dr. O'Sullivan:

Q. You may proceed.

A. This is the table:

884 Oxygen Depletion in New York Harbor.

1909-1919.

	Per cent saturation.				Per cent of 1909 value.			
Year.	Narrows.	Robbins Reef.	East River.	Hudson River.	Narrows.	Robbins Reef.	East River.	Hudson River.
1909	17	26	35	27	100	100	100	100
1911	21	27	46	39	124	104	131	144
1912	21	36	50	43	124	139	143	159
1913	28	31	59	49	165	119	169	182
1914	32	29	60	50	188	111	171	185
1915	21	28	67	58	124	108	191	215
1916	36	36	74	54	212	139	212	200
1917	37	50	70	61	218	192	200	226
1918	32	44	79	46	188	169	226	170
1919	42	49	76	64	247	189	217	237

The Witness: In order to make these data comparable over the various areas, I have also converted them to a common basis by taking the 1909 depletion values at each station as unity, or 100%, and computing the succeeding values relatively to these. Finally, these relative values for the four areas have been averaged into one set of values showing for the whole harbor the depletion from year to year, measured in terms of the depletion for the year
885 1909.

The following results have been obtained. This is the single list of figures, and I will read it in.

Mr. Riker: This is supposed to be an answer to the question, I suppose. The reading of this line of figures is objected to as being based upon data which is not properly in evidence in this case, and not properly proved.

The Commissioner: Note the objection of counsel for the defendants.

The Witness (continuing):

Ave. Depletion in	1909	taken as a basis	1.00
" "	"	1911	1.26
" "	"	1912	1.41
" "	"	1913	1.59
" "	"	1914	1.64
" "	"	1915	1.60
" "	"	1916	1.91
" "	"	1917	2.09
" "	"	1918	1.88
" "	"	1919	2.22

Evidently the depletion is increasing at a more rapid rate than the population increase. This is what would be anticipated, and illustrates the futility of basing a measure of the capacity of the harbor to digest sewage upon an assumption of anything like complete depletion. As the oxygen is decreased, the normal di-
886 gestive reactions are slackened and the reactions leading to putrefactive conditions are accelerated.

Q. Prof. Phelps, do you conclude that the depletion is increasing at a more rapid rate than the population increase?

A. It appears from the data that I have submitted, that the depletion is more than doubled in 1919, as compared with 1909; whereas, at a conservative estimate, the increased population is not over 50 per cent increase.

Q. Have you made any estimates of the capacity of the harbor for sewage, based upon Mr. Whipple's estimate or assumptions that seem to conflict with your facts?

A. No correct estimate of the effect of sewage pollution upon waters like those of New York Harbor can be made without giving full consideration to the bio-chemistry of the sewage itself. Professor Whipple has attempted such an estimate, and expresses the opinion that the sewage from between 7.5 and 30 million people

may be discharged into these waters without nuisance (page 404, stenographic minutes).

Under cross-examination (page 500 of stenographic minutes), he said that this estimate was "based on the well known fact that four cubic feet of water per second for each 1,000 persons is regarded as a sufficient dilution to prevent nuisance during the summer conditions." He further assumes (page 501, stenographic minutes) that all the oxygen entering the Narrows is available for sew-
887 age oxidation in the bay and rivers."

Neither of these assumptions is justified in fact. Four cubic feet per second per 1,000 persons, is a figure for running streams where reaeration is active, and includes the reaeration effect. I have made an extensive study of reaeration conditions in New York Harbor, and also in the Ohio River. My data show conclusively that as compared with river conditions, the deep and relatively quiescent waters of New York Harbor are subject to relatively little reaeration.

The assumption that all the oxygen entering the Narrows is available is also fallacious. In the first place it would be inconceivable that a condition like that now existing in the Passaic River would be tolerated in New York Bay. To say that the Bay can dispose without nuisance of an amount of sewage calculated to exhaust all its oxygen, is a contradiction of terms. Moreover, the water entering the Narrows is not distributed uniformly over the Upper Bay and rivers, and long before the complete exhaustion of oxygen is reached near the Narrows, the upper harbor waters will have become entirely anaerobic. A casual inspection of any of the oxygen figures in evidence will make this fact plain. The depletion of oxygen is least at the Narrows and increases upstream.

888 Upon these assumptions Professor Whipple arrives at a population of 15 million people as a safe upper limit. This value he doubles for reaeration (page 501 of stenographic minutes) although stating (p. 502, stenographic minutes) that "no one can tell how much oxygen will be absorbed from the air," and overlooking the obvious fact that his initial datum of four second feet of diluting water per 1,000 population is for rivers, and already includes a reaeration effect admittedly greater than that in the harbor.

In 1910, in a report to the Board of Estimate and Apportionment of New York City, which is Complainants' Exhibit No. 136 in this case, Colonel Black and I computed the capacity of New York Harbor to receive and oxidize sewage without too great a reduction of the dissolved oxygen. We concluded that if all the sewage could be discharged at the Narrows, which is equivalent to assuming a uniform admixture of the sewage in the entire tidal flow, the sewage from 7.4 million people could be discharged without depleting the oxygen of the harbor below 70%. We estimated, on the basis of a most careful study of reaeration, that this 30% depletion would be accompanied by reaeration, equivalent to about one per cent. of the saturation value.

Mr. Riker: Now I move to strike out that testimony as to the contents of the oxygen, of Col. Black's studies with him, on the ground that the original exhibit was put into the case under
889 objection, and is not legal evidence, and that the conclusions now stated by the witness, in the narrative form of testimony adopted by him, are not based upon any proven fact.

Mr. McCarter: Counsel for the defendants further calls attention of the Court to the fact that the witness is reading the whole matter that he is testifying to, from a carefully prepared argument; that the purported testimony is really not testimony but an argument, which should be made by counsel and not by the witness. He is taking advantage of exhibits that are not legally in the case, and it amounts really to an argument and not evidence, all of it being read carefully from manuscript in his possession.

The Commissioner: Note the objections of Mr. Riker and Mr. McCarter, of counsel for the defendants.

Q. Prof. Phelps, what were you just reading from?

A. From notes which I have prepared in anticipation of testifying in this case.

Mr. Riker: May I ask a question now, a question of counsel, to qualify a witness to read from notes?

By Mr. Riker:

Q. You are reading verbatim, are you not?

A. Yes, sir, nearly so. I am interpolating, as it occurs to me, when something ought to be explained a little.

By Dr. O'Sullivan:

Q. In Exhibit No. 136 of the complainants, who did the
890 oxygen work during that 12 months, of New York Harbor waters in the joint report between Col. Black and Prof. Earle B. Phelps?

A. I was responsible for it.

Q. Was not the function especially assigned to you?

A. Yes, sir.

Q. Are you familiar with the oxygen determinations in that report which are known in this case as Complainants' Exhibit No. 136?

A. Yes, sir, entirely so.

Q. Is it your own work?

A. Yes, sir.

Q. You may proceed, Professor.

By Mr. Riker:

Q. You mean that you made the oxygen determinations yourself—can not you answer that question? It calls for yes or no.

A. No, sir, I can not answer, because I want to understand what oxygen determinations mean. I understood Dr. O'Sullivan to mean in his question, the mathematical analyses. These were a very small

body of actual analytical work done in connection with this study; it is a mathematical analysis of conditions; and in that sense, I did all that oxygen work myself.

Q. Did you do the oxygen determinations yourself, in the samples?

A. No, sir, those samples that were actually collected, were done by Mr. Carpenter, under my supervision.

By Dr. O'Sullivan:

Q. Under your supervision?

A. Yes, sir.

Q. The Mr. Carpenter whom you have already described
891 and worked with in July of this year?

A. Yes, sir.

Q. Did you make forecasts in Complainants' Exhibit No. 136 as to probable conditions that would exist about the present time?

A. We made forecasts in the form of formulas, which are applicable to the present day, yes, sir. We did not compute this particular year at that time.

Q. Have those forecasts been partially or completely realized since?

A. Under the necessary conditions of discharge as they exist at the present time the sewage from this same population would bring about much more serious effect. Our formula indicated in that case an average oxygen content of the Upper Bay of 42%.

Actual determination this year gives an average condition of this area of 44%. The population is somewhat indeterminate as there is so large a portion of the actual contributing population that is not represented in the census figures. If the large floating population of New York City be taken into account, the total contributing population on this water-shed is probably not far from seven million. The formula used in 1910 in the above described computation would give for a population of seven million, an average condition of the Upper Bay of 45% of oxygen.

I wish to point out in particular that these computations are made upon the basis of my reaeration studies on New York Harbor. The
matters that I have just discussed are introduced to show that
892 reaeration as a factor in the protection of the harbor waters has been correctly measured by me. If such were not the case, no such close agreements between population and the computed and actual conditions of these waters would appear.

In brief, my views as to the population which may continue to sewer into these waters without bringing about a nuisance differ from Mr. Whipple's only in the preliminary assumptions of fact. I assume a permissable depletion over the whole harbor on the average and in the summer time, of 30% bringing the oxygen down to 70% of saturation. This condition of the water results in a degree of reaeration equivalent to less than one per cent. of saturation for the whole body of water.

Mr. Whipple assumes that a total depletion of the oxygen is permissible without nuisance and that the sewage is all uniformly distributed throughout the waters of the harbor. This assumption leads to his estimate of 15 million people. He further assumes a reaera-

tion effect equivalent to an additional 100 per cent. of saturation upon the basis of which he doubles his population limit.

Under the necessary conditions of discharge along the waterfront the ideal condition of uniform distribution throughout the harbor waters can never be attained. This is only possible were the sewage all taken to the Narrows or to Throgg's Neck. It is no answer
893 to this obvious fact that conditions would be improved were the sewage taken out into the main channels of the rivers. Such a procedure would admittedly improve the shore conditions but would have no effect whatever upon the general conditions of the harbor waters as a whole. The dissolved oxygen figures which I have put in evidence are those of the main channels. In my own work I have purposely avoided the more polluted shore waters and in compiling the results of past years only channel values for the rivers have been included. These channel waters have passed to and fro with the tidal movements and always contain their full quota of the sewage regardless of the manner of discharge. To carry all the sewage into the main channels would undoubtedly improve the condition of the main stream but it would not materially affect the condition of the latter into which all the sewage ultimately flows.

In addition to his assumption as to total depletion of the oxygen and large aeration effect, Mr. Whipple assumes a uniform admixture of the sewage throughout the water and his estimate of population limit is based upon such admixture.

In my opinion, Mr. Whipple's assumptions are unwarranted and unjustifiable, and his estimates based upon those assumptions are quite unreliable.

894 Q. In 1910, Prof. Phelps, did you make an estimate of the effect of a given population upon the harbor through sewage discharge?

A. Yes, sir.

Q. Will you compare that estimate, state what it is and compare it with the assumptions made by Mr. Whipple?

Mr. Riker: The question is objected to as being immaterial and irrelevant, and the computation of this witness except in so far as based upon proven facts, is of no value in the case.

The Commissioner: Note the objection of counsel for the defendants.

Q. Also state where that estimate is to be found, whether or not in Complainants' Exhibit No. 136.

A. That estimate is found in Complainants' Exhibit No. 136. Comparing briefly the two bases of estimate adopted, on the one hand, by Col. Black and myself, and the other by Mr. Whipple, we assumed that the oxygen could be depleted 30 per cent, that is, down to 70 per cent without nuisance, and that that extent of depletion is as far as it is safe to go on the average. The average condition of 70 per cent means an actual minimum condition in the more grossly polluted areas very much lower. We further assumed actual and necessary conditions of sewage discharge. Mr. Whipple's computa-

tion is based upon an assumption of total depletion and uni-
895 form distribution of the sewage throughout the waters of the Harbor, which can only be achieved by discharge at the Narrows, or at Throgg's Neck, the two entrances to this harbor. Those two differences in our estimation account primarily for the difference in our estimates.

Q. Would you regard the present condition of the harbor as a satisfactory test of this matter?

Mr. Riker: What matter?

Dr. O'Sullivan: Of the two conflicting assumptions: The estimate made by Mr. Whipple as to the population that could be accommodated in New York Harbor waters; the forecast made by Prof. Earle B. Phelps in 1910, and its realization in 1919; Mr. Whipple basing his assumption upon two series of oxygen determinations, one on a flood tide of November 3, 1909, where a number of the samples were taken, in the Narrows, from the incoming refreshing water, and the other samples taken on May 3, 1919, in the Narrows, with conflicting results even in his own samples. I am now asking this question——

Mr. McCarter: It is not a question which counsel just read.

Dr. O'Sullivan: I am answering a question put by counsel for the Passaic Valley Sewerage Commission.

Mr. Riker: Yes, but I move the whole answer to my question be stricken out, as containing an assumption which counsel is
896 not justified in by the evidence in the case.

The Commissioner: Note the motion of counsel for the Passaic Valley Sewerage Commission.

Q. How would you apply the present condition of the New York Harbor waters, as a test to measure the correctness of the assumptions made by yourself in 1910, and by Mr. Whipple in 1919?

Mr. Riker: Do I understand that the preceding question is not answered, or that the witness is unable to answer it?

Dr. O'Sullivan: These two questions do not conflict. It is making more definite the preceding question which I withdrew.

Mr. Riker: The preceding question is withdrawn and my objection is withdrawn.

A. The most satisfactory test of this whole matter is the present-day conditions. These have been sufficiently set forth in the analyses of the past few years.

The Harlem River has for some time past been polluted so seriously as to constitute a real nuisance in warm weather. The waters of the East River, on the ebb current, smell distinctly of sewage at the present time. The oxygen in the Hudson is decreasing steadily from year to year, and it is obvious that it cannot continue to support increasing sewage loads.

The kind of ideal mixing and diffusion of the sewage
897 throughout the entire body of the harbor waters which is assumed in all the computations and estimates that have been made is practically out of the question and a very large margin of

safety must be allowed. In proposing a limit of 70% of saturation as an average value for all the water, I had the fact definitely in mind that many parts of the harbor would unavoidably be much below this figure. Present conditions amply justify the estimates of nine years ago. Without some radical and apparently impossible changes in the method of discharging the sewage, the capacity of New York Harbor to receive and dispose of sewage without nuisance is already exceeded and relief must be sought, as it is being sought, in partial purification of the sewage before discharge.

Q. In your various studies and analyses and investigations, Prof. Phelps, have you found that a nuisance can exist where oxygen is still found in the waters from which the nuisance emanates?

A. The most serious nuisances that exist in polluted waters are undoubtedly observed in those streams, which like the Passaic River, have been so overloaded with sewage as to have become entirely anaerobic, but it is not true as has been contended that no nuisance can occur as long as there is any dissolved oxygen present. To obtain data upon this point, supplementing that which I have previously testified to in the case, I have been careful to note
898 the odors of various samples of the waters, especially in the East River. On July 22nd, when the dissolved oxygen at Pier 10 was 16 per cent, I recorded in my notes a strong musty odor of sewage origin. On July 18th, at the same station, the odor recorded was "distinctly sewage." The oxygen was 11 per cent.

On July 22nd, I made a trip up Newark Bay, between the hours of 10:00 a. m. and 1:00 p. m. The tide was nearing the end of the ebb. The water was noticeably discolored in the Kill Van Kull, a fact attributed at first to local pollution, until it was observed that the discoloration was continuous and continuously increasing as we proceeded.

A surface sample was taken at the Centreville Light. The odor was "strong, musty," as recorded by myself, and "slight sewage," as recorded by Mr. Carpenter, my chemical assistant.

Mr. Riker: I move to strike out that part that refers to Mr. Carpenter, as not being proper proof in this case, and hearsay.

Dr. O'Sullivan: Counsel for complainants offers to produce Mr. Carpenter, if counsel for defendants will waive the limitation to the three witnesses prescribed by the order of the Supreme Court of March 10th, 1919.

Mr. Riker: Counsel for the defendants in this case is unable to modify the order of the United States Supreme Court.

899 The Commissioner: Note the motion of counsel for the defendants to strike out.

The Witness (continuing): The dissolved oxygen was 11 per cent. At the Lehigh Valley Railroad Bridge, the odor of sewage was noticeable from the boat and was commented upon by all of the party. The oxygen value was 6 per cent, and the recorded odor of the bottle sample "strong sewage". At the next stop, Central Railroad bridge, in the Passaic River——

Mr. Riker: The same motion as to striking out that answer.
The Commissioner: Note the motion of counsel for the defendants by striking out.
Dr. O'Sullivan: Strike out what?
Mr. Riker: The testimony of the witness as to the impressions of the parties present, as to the sewage odor, it is hearsay.

The Witness (continuing): At the next stop, the Central Railroad Bridge, Newark Branch in the Passaic River——

Dr. O'Sullivan: Just one moment.

Q. Prof. Phelps, were those men who expressed their olfactory impression from the odors from the Passaic River working directly under your supervision and your direction?
A. Yes.

Mr. Riker: The question is objected to as immaterial and
900 irrelevant, and the statements are equally hearsay, which are being repeated by this witness.
The Commissioner: Note the objection of counsel for the defendants.

Q. Proceed.
A. At the next stop, Central Railroad Bridge, in the Passaic River, Newark Branch, the odor from the surface was nauseating and the bottle sample was recorded "strong offensive".

Mr. Riker: I object to this narrative testimony which shows that the bottle sample was recorded as "strong offensive", and request that it be stricken out as hearsay, and immaterial and irrelevant.
The Commissioner: Note the motion of counsel for the defendants to strike out.

Q. Did you yourself personally note the strong offensive odor from the river?
A. I did, the dissolved oxygen was 5 per cent.
Q. At the time that you noted this strong offensive odor?
A. Yes, sir.

Mr. Riker: That statement volunteered, I move to strike out on the ground that this witness has said that he did not make the examination and it is therefore hearsay.
The Commissioner: Note the motion.
Mr. McCarter: The same thing is true of the analyses of the dissolved oxygen at the other Lehigh Valley Bridge and the
901 other places noted in the said river.
The Commissioner: Note the objections of counsel for the defendants.

By Dr. O'Sullivan:

Q. Prof. Phelps, were these oxygen determinations of 11 per cent, 10 per cent, 6 per cent and 5 per cent, which you have just now testified to, made in your presence?

A. Yes, sir. Every step was done under my immediate observation, and I made the records myself.

Q. Will you swear positively that these oxygen determinations are accurate, that you have just testified to, of 11 per cent, 6 per cent, and 5 per cent?

A. Yes, sir.

Q. Prof. Phelps, were any biological studies, examinations and determinations made during the month of July, under your direct supervision and under your direction?

A. Throughout the course of the work which I have described, samples were taken at the same stations and times and depths as those recorded for the dissolved oxygen work, and were later submitted to examination for bacteria, and some of these samples, namely, those of July 9th, 10th, 11th and 12th, were submitted to microscopic examination for the determination of the larger microscopic life.

At the laboratory, I undertook to determine the total number of bacteria capable of developing at 20 degrees centigrade of
902 standard culture media, and also the specific organism B-coli, indicative of sewage pollution.

Mr. Riker: This testimony of the witness is objected to on the ground that it has not been shown that he took the samples or knows anything about their being taken, and therefore the results of his sampling are of no value in this case, and therefore I move to strike it out.

Dr. O'Sullivan: Complainants' counsel has offered to produce Mr. Bonney, and Mr. Frost who, under this witness's direction and supervision, did the biological and bacteriological work, if counsel for defendants will waive the limitation of counsel for plaintiffs producing more than three witnesses.

Mr. Riker: Counsel for defendants is unable, as he has already said, to modify the order of the Supreme Court, with reference to the number of witnesses that are permissible under the order in question.

The Master: Note the motion and objection of counsel for the defendants.

Q. You may proceed and complete your answer to my question.

A. The results of these biological examinations are contained on the sheets which I have already read into the evidence under the headings "Bacteria per Cubic Centimeters"; sub-headings "at 20° C." and "B-Coli", and under the heading of Sheet 1 only, "Micro-organisms per c. c.", and sub-headings "Standard units", "Predominating genera."

903 The results of the bacterial examinations show in general grossly polluted water, as is evidenced by the high number of bacteria, and in particular the large number of the specific sewage organism, B-coli, which were found present in all these waters in numbers ranging from, almost without exception, 1 to 1,000 per cubic centimeter. In a few exceptional cases, where a zero was recorded, the value was actually indeterminate and not properly zero, the zero merely indicating that in the dilution employed for the

examination, there were no organisms present. The result of the microscopical examination by which we determined those larger form of microscopic life, actually visible to us as distinct organisms, with their own characteristics observed under the microscope, indicate a very great predominance of the organism melosira, a diatome, a very low order of plant life.

This organism occurred in relatively small numbers as compared with its occurrence in reservoirs and other natural bodies of unpolluted water, and the almost total absence of other forms of life was particularly noticeable.

Q. Did you find any chlorophycea, or other chlorophyll-bearing organisms?

A. Chlorophycea, or other chlorophyll organisms were distinctly absent. In only three cases was there any evidence of these higher green plants, and in two of these cases the plants had a
904 yellow cast rather than a bright green characteristic of a living organism, indicating that they were actually dead or dying. In only one case in the entire number of examinations were there any living active chlorophyll-bearing organisms found.

Q. What is the function of chlorophyll-bearing organisms, and chlorophycea in the presence of bright sunlight?

A. In nature, in general, they function to fix the energy of the sun utilizing it for the manufacture of organic compounds from the carbon dioxide of the air. In streams and in our study of stream pollution, their chief interest is in their function of reaeration of water. When present in natural lakes and ponds, in large numbers, and in the presence of sunlight, they serve as important factors in reaeration.

Q. When you use the term "reaeration", Professor Phelps, do you mean to imply the addition of dissolved oxygen to the water?

A. Yes, sir. That usage has come to be recognized, although it is not a very strict one. One might better say re-oxygenation. I have observed in waters densely populated with green plants, oxygen values up to 300 per cent of saturation; but in those cases, the numbers present were perfectly enormous, so that the waters had a greenish cast from the presence of these small living plants.

Mr. Riker: I move to strike out this interesting professorial statement of scientific facts, which have no materiality to the question at issue in this case.

905 Dr. O'Sullivan: The motion of defendants' counsel is opposed, on the ground that their chief witness, Mr. Whipple, attributed the oxygen content of New York harbor waters in large part, to the functional activity of chlorophycea, and the other chlorophyll-bearing organisms, and that this examination by the present witness was conducted especially to determine whether or not such organisms existed in any considerable numbers; and if so, if the turbidity of the harbor waters would permit the sunlight penetrating and inducing the functional activity of these organisms which this witness has testified were conspicuous by their absence.

The Commissioner: Note the motion of counsel for the defendants.

Q. Professor Phelps, from the series of oxygen determinations and biological and bacteriological analyses, that have been conducted by you and directly under your supervision during the month of July, 1919, and from your studies of the two thousand and odd oxygen determinations that have been taken during the period between 1909 and the present year, and from your knowledge and investigation of harbor water conditions, have you arrived at any conclusions as to the present condition of our harbor waters for the digestion of sewage, and receiving added burdens of sewage, and disposing of it harmlessly?

906 Mr. Riker: The question is objected to as not being an hypothesis based upon proven facts, and the conclusion of the witness under those circumstances being of no value in the case, and not probative of anything.

The Commissioner: Note the objection of counsel for the defendants.

A. My studies have led me to the following conclusions and opinions:

The dissolved oxygen in the waters of New York Harbor is decreasing progressively from year to year. The rate of this decrease appears to be greater than the rate of increasing population. In 1919, the average depletion is more than twice as great as it was in 1909.

Estimates of permissible pollution based upon an assumption of total oxygen depletion are entirely inadmissible because of the inevitable association of this condition with nuisance. My special studies of this point during the present summer have confirmed the opinion that I had previously formed that definite nuisance, including discoloration of the waters as a whole and the evolution of offensive odors are likely to occur when the dissolved oxygen reaches as low a figure as 15 per cent and that nauseating conditions are compatible with a dissolved oxygen value of five per cent.

Estimates or assumptions as to the extent of reaeration under conditions of total depletion are therefore irrelevant.

907 Under any acceptable condition of the water as to oxygen depletion, no material relief may be expected from reaeration. This has been shown by a most careful study of reaeration phenomena in New York Harbor and by extensive studies of reaeration in the Ohio River in the course of which the laws of reaeration developed in 1910 for New York Harbor have been demonstrated and confirmed.

Mr. Riker: I move to strike out that last statement as being hearsay, and not founded upon any fact present.

Dr. O'Sullivan: That motion is opposed on the ground that this witness has testified that he personally conducted these very experimental determinations in the Ohio River, in regard to reaeration.

The Commissioner: Note the motion.

The Witness (continuing): The present condition of the harbor waters is evidence that they are now overburdened, not alone along

the shore lines but in the channels and the main bodies of water. Local relief may be found in adjusting the distribution more equitably from the more grossly to the less grossly polluted areas. No system of redistribution, however, that is feasible nor any method of discharge into the deeper channel waters can improve the general condition of these waters, which is the unavoidable result of
908 the admixture of a specified amount of sewage pollution with the available body of water.

Purification treatment is demanded and furnishes the only feasible plan of relief, and restoration.

The Commissioner: The time for recess has arrived, gentlemen. We will adjourn until two o'clock.

(Recess until 2:00 p. m.)

909 After Recess.

2:00 p. m.

Prof. EARLE PHELPS, resumed:

By Dr. O'Sullivan:

Q. Prof. Phelps, have you prepared a diagram showing the progressive depletion in the waters of New York Harbor based upon the oxygen determinations?

A. Yes, sir.

Q. Have you got it?

A. Yes, sir, I have it here (produces paper).

Dr. O'Sullivan: I offer in evidence the diagram produced by this witness showing the progressive depletion in dissolved oxygen in New York Harbor waters, and ask that it be marked Complainants' Exhibit No. 254.

By Mr. Riker:

Q. Who prepared this diagram?

A. It was prepared by a draftsman in my office.

Q. Did you have anything to do with the preparation of it?

A. Yes.

Q. What?

A. I prepared all the figures and did everything but the actual drawing.

Q. And after it was finished, did you verify it?

A. Yes, sir, very carefully.

Q. What was the data upon which this diagram was based?

A. It was based upon the data contained in the large table headed "New York Harbor, Dissolved Oxygen, Summary of 2814
910 examinations, 1909-1919."

Q. From all of those matters?

A. The data on the first line of the table——

Q. This is the summary, I take it, you are speaking of now?

A. Yes, sir—the data on the first line of the table marked "Whipple, 1909, November 4-5;" and the data on the eleventh line marked "Whipple, 1919, May 3rd," and the two succeeding lines marked "Phelps, 1919, July 7th, to 15th," and "Phelps, 1919, July 15th to 31st," have been omitted from this diagram here.

Q. What does the reading matter in this diagram "Phelps' Values, 1919" refer to?

A. That refers to the last line of the table, which is my average for the entire month; the omitted lines being partial averages for two parts of the month, prepared for a special reason, for comparison.

Q. Then this is nothing more than, and perhaps nothing less than, a graphic delineation of the matter which appears in the table which you have read into the record, "New York Harbor, Dissolved Oxygen, Summary of 2814 examinations, 1909-1919," omitting the ones that you specially referred to of Mr. Whipple's and of yourself?

A. Yes, sir.

Q. And purports to be based upon determinations of oxygen not made by you?

A. Yes, sir.

Mr. Riker: The offer is objected to on the ground that it delineates as facts matters which have not been proved in this
911 cause, and is therefore immaterial, irrelevant and hearsay.

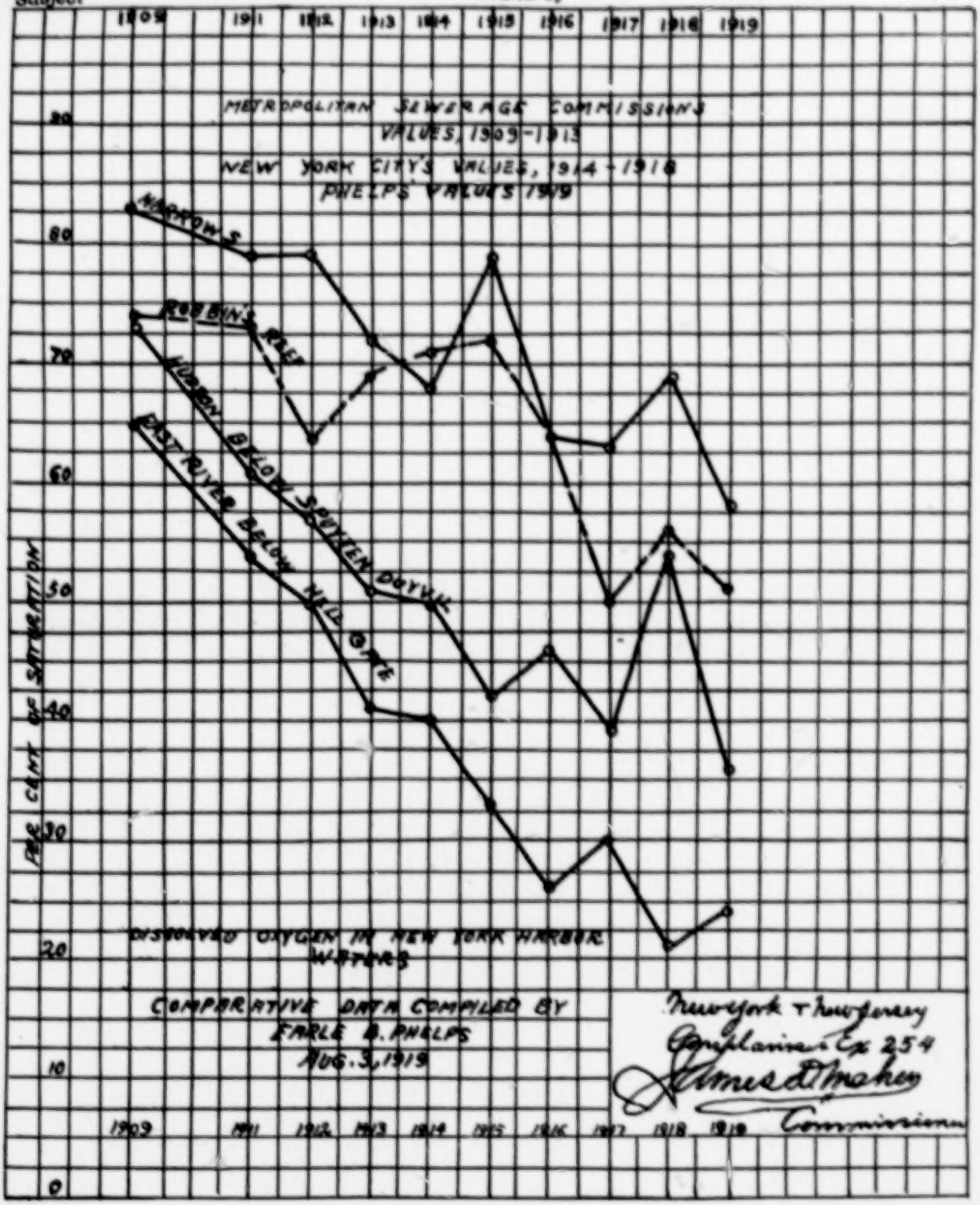
The Commissioner: Note the objection of counsel for the defendants.

(The paper was marked Exhibit No. 254.)

Dr. O'Sullivan: He is your witness, Mr. Riker.

(Here follows diagram marked page 911a.)

Subject Drawn by Date 19



Cross-examination.

By Mr. Riker:

Q. Prof. Phelps, will you tell me how old you are?
A. I am 43, sir.
Q. From what college did you graduate?
A. Massachusetts Institute of Technology.
Q. What age were you when you graduated from that college?
A. I was 23, I think. Yes, I think, 23.
Q. During the time intervening between your graduation and the present time, in what have you been engaged?
A. I was engaged for four years in studies of water and sewage purification at the Lawrence Experiment Station of the Massachusetts State Board of Health, Lawrence, Massachusetts. I was employed there in the capacity of Assistant Bacteriologist. During the following ten years, about, I was employed by the Institute of Technology in Boston as Chemist of the Sanitary Research Laboratory.
Q. In what year did that employment terminate?
A. 1913. During that period I had various other lines of activity, building up a considerable part of my consulting practice in
912 sanitary engineering; and, as I have already said, these appointments as Special Agent of the United States Geological Survey, to carry out investigations for them on industrial wastes; and I was also appointed by the Census Bureau during that period, as a Special Agent in connection with tabulation of statistics for water supply and sewerage works. I was retained by the City of New York, as I have indicated, and by many other municipalities and individuals; and I have had a varied experience in legal cases, and so forth.
Q. Subsequent to 1913, what has been your employment?
A. Up to March of this year, I have been employed by the United States Public Health Service at Washington; and I have had charge of their investigations of stream pollution, industrial waste disposal and sewage disposal; and I was retained by the International Joint Commission for a period of three years to make examination and report on the pollution of the international waters, that Commission being composed of American and Canadian representatives.
Q. Associated with Mr. Fuller in that work?
A. Not directly, no, sir. Mr. Fuller was consulted at one time.
Q. Also Mr. Whipple?
A. Yes, sir.
Q. What else have you done since 1913?
A. Why, I think I have pretty well covered my record.
Q. Have you been employed by the City of New York during that period?
A. I mentioned that, yes, sir.
913 Q. In what capacity?
A. As Consulting Engineer, to investigate and report upon the pollution of New York Harbor, with special reference to the dis-

position of sewage, and the probable capacity of the harbor to receive sewage without nuisance.

Q. Were you employed by the City of New York in 1915?

A. No, sir, I do not think I was.

Q. What years were you employed by the City of New York for these investigations?

A. The year 1910 is the year I have reference to.

Q. You have not been employed since then by the City of New York?

A. No, sir.

Q. Have you ever done any construction work in the matter of drainage or sewage disposal?

A. Yes, sir.

Q. Where?

A. My answer implies the engineering features of construction work. I have designed and supervised the construction of sewage disposal plants for Margate City, New Jersey; Ocean City, New Jersey; Ventnor, New Jersey; these are all small coast cities, seaside resorts. I designed works for the City of New Bedford, for the sterilization of the sewage. That is all that I recall, Mr. Riker.

Q. The New Jersey municipalites for which you have done some constructive engineering work, are all small suburban places, located on the ocean?

A. Yes, sir.

Q. Had no harbor problems to deal with?

A. No, sir.

914 Q. And your New Bedford work was only a matter of applying to existing work sterilization processes, wasn't it?

A. No; it was a little more than that; an entire new project was under consideration, and I was called upon to design, in connection with the City Engineer, the disinfection part of the works, and also to consult with him as to the general problem of protecting the harbor from pollution.

Q. When was that?

A. That was approximately 1911 or 1912.

Q. Were the works constructed under your supervision?

A. No, sir.

Q. Your work has been very largely laboratory work, has it not?

A. No, sir, not in this connection; it has been more largely consulting work, which generally ends where construction begins.

Q. But you were never concerned in any construction except in the instances which you have named?

A. Oh, there were other instances, but they are all small; I built a good many small private sewage disposal plants for private estates. I built a plant at the Rahway State Reformatory, at Rahway, New Jersey.

Q. You have mentioned Col. Black in your testimony in several places, Professor. Are you familiar with Complainants' Exhibit No. 135, in this cause, which is the stipulation between the United States and the State of New Jersey and the Passaic Valley Sewerage

915 Commission?

A. Yes, sir, I was quite familiar with it at one time.

Q. Do you know whether Colonel Black had anything to do with that stipulation?

A. I think he had a good deal to do with it. Just how much I can not say.

Q. You have said in your direct testimony, that the spring of 1919 was a late spring, haven't you?

A. Yes, sir.

Q. Why did you say that?

A. Why, that is a matter of lay observation rather than expert opinion. I maintain a garden, and I know it was a late spring for gardening, and my rose garden was behind normal in coming out. There were many evidences of a late spring.

Q. Do you know what it was due to?

A. Meteorological conditions. I can not go beyond that.

Q. Lack of precipitation?

A. No, sir, I do not think that is the cause. I think it is a question of temperature.

Q. Is it not a fact that there was practically no winter in 1918-1919?

A. The winter was unduly mild.

Q. Do you know whether the ground was actually frozen to any considerable extent at any time?

A. Yes, sir.

Q. Was it?

A. It was frozen.

Q. How late was it frozen?

A. I can not say.

Q. Bearing in mind the character of the winter, you still think that the spring was a late spring, do you?

A. Yes.

Q. Now you have testified to precipitation in 1919. Have
916 you any records of precipitation from which you have testified?

A. No, sir. It is merely based on memory and observation of the existing conditions.

Q. I think you have testified that excessive precipitation would have a tendency to increase the dissolved oxygen of the water in the summer time?

A. Yes, sir.

Q. Has there been any undue precipitation in this summer of 1919?

A. Yes, sir; we had a spell of weather, beginning with the 15th of July, which was rather unusual in the extent of precipitation.

Q. Didn't it begin earlier than the 15th of July?

A. I think I am correct on that. I think that is St. Swithins Day.

Q. Wasn't there a heavy precipitation on July 11th?

A. I do not recall it, sir.

Q. Do you recall anything about July 11th, so far as precipitation is concerned?

A. No, sir.

Q. Have you any recollection of having rainfall before July 15th, during the month of July?

A. No, sir.

Q. You do not remember anything about it at all?

A. I do not recall what the weather was.

Q. Do you recall any extreme temperatures in July?

A. My recollection is that we had a spell of rather hot weather during the first ten days, and then it was a little cooler.

Q. Would not weather have a tendency to decrease the dis-
917 solved oxygen in the waters of New York Bay?

A. Well, not short spells. That effect is cumulative, and rather slow. It is necessary for the water itself to become warm, and the waters do not respond quickly to changes in the atmospheric temperature.

Q. Do you remember whether we had a spell of extremely warm weather in the beginning of June?

A. No, sir.

Q. You do not remember that?

A. No, sir.

Q. Do you remember the temperature on Decoration Day, the 30th of May?

A. No, sir, I don't.

Q. Were you in this part of the country at that time?

A. Yes.

Q. And you do not remember whether there was a week or ten days of extremely hot weather at the beginning of June and the last of May?

A. No, sir, I could not say from recollection.

Q. Assuming, for the purposes of this question, that the record on this sheet which you have read into the record bears a summary of examinations of dissolved oxygen, taking the Narrows, Phelps, 1919, July 7th to 15th, the average percentage of dissolved oxygen was 68, was it not?

A. Yes, sir.

Q. And for July 15th to 31st it was 53?

A. Yes.

Q. How do you account for the falling of the dissolved oxygen in the last two weeks of July, as compared with the second week in July?

918 A. By the cumulative action of the gradual warming-up of the water.

Q. The cumulative action of the warming-up of the water?

A. Yes.

Q. Which occurred during what period?

A. That is a constant phenomenon throughout the summer.

Q. Well, I am not dealing now with the general conditions. I want you to take the conditions of this year. You have testified that there was an unusual precipitation from the 15th of July for ten days?

A. Nine days, I think.

Q. Nine days?

A. Yes.

Q. Where do you see the effect of that precipitation reflected in the dissolved oxygen at the Narrows during the last two weeks of July?

A. It is not reflected there.

Q. How do you account for the drop of 15 per cent in the dissolved oxygen in those two weeks, as compared with the second week of July?

A. As I have already said, it is a cumulative action of the temperature of the water.

Q. The precipitation, then, which was extreme during the period from the 15th to the 24th of July, had no effect in increasing the dissolved oxygen?

A. It probably did have an effect, but that effect was more than counterbalanced by the cumulative effect of the high temperature.

Q. When did the cumulative effect of the high temperature begin to appear, in your judgment?

A. Just as soon as the temperature began to go up in the spring.

919 Q. And you think it accumulated during the period of heavy precipitation in July?

A. Yes, sir, the precipitation had nothing to do with it.

Q. Do you know what the temperatures were during the period of heavy percipitation in July?

A. The water temperatures?

Q. The air temperatures.

A. No, sir, I did not record those.

Q. Would they have any effect upon the dissolved oxygen in the waters of New York Bay at the Narrows?

A. Indirectly, in so far as they affect the temperature of the water, and only so far.

Q. You believe that the record which you have put down here in this summary is justified by accumulation of heat during the last two weeks of July as compared with the second week in July, do you, notwithstanding the precipitation and notwithstanding the reduction of the temperature of the air during those two weeks?

A. Not exactly an accumulation of heat. It has rather a cumulative effect. Perhaps I ought to explain that in more detail. We may conceive of the water rising in temperature from the neighborhood of freezing point in the winter to, let us say, 20 degrees Centigrade, around the first of June; and then staying at 20 degrees Centigrade for about a month or two without material further increase. Now, we do not get the worst oxygen results at the same time that

920 the temperature reaches the highest point, but from that time on the oxygen results continue worse and worse. That is what I mean by cumulative effect. The high temperature speeds up the reaction of the deoxygenation, so that the reaction goes faster and faster until it gets to a very high rate; so that it is not temperature alone of the water which determines the oxygen, but it is also the time that has elapsed since the water has been at that temperature.

Q. How long do you think, judging from the difference in dissolved oxygen in the last two weeks of July, as compared with the second week—how long do you think the temperature has been increasing and the dissolved oxygen decreasing in the waters of New York Bay?

A. The temperature has been increasing since some time in the writer or early spring, and the dissolved oxygen has probably been decreasing slowly at the same time. But during the course of my investigations, there was no marked change in the temperature. During the month of July the temperature had about reached its maximum, and the dissolved oxygen is continuing to fall off, as is evidenced in these average values.

Q. When you say that the temperature in July was at its maximum, do you mean by that during the month of July?

A. I am referring to water temperatures in this discussion,
921 not air temperatures. It is the water temperature that affects these things.

Q. How is the water temperature increased or decreased?

A. By the air.

Q. Then doesn't it depend upon the temperature of the air?

A. It does, but not directly and definitely. There is no necessary relation between the two, except that if one goes up the other goes up.

Q. You say there is no necessary relation?

A. No, sir.

Q. Except that as one goes up the other goes up?

A. As a general rule, but not always every time; a sudden drop in the temperature today won't affect the harbor today or tomorrow appreciably.

Q. It won't affect it immediately, is that what you mean?

A. No, sir.

Q. It will ultimately, won't it?

A. Not if it gets warmer again tomorrow, it won't.

Q. You mean just a drop in the temperature of the air for a day will not necessarily affect the temperature of the water, if the temperature of the air is restored within 24 hours.

A. Yes, sir.

Q. What natural phenomenon, in your judgment, accounts for the drop in dissolved oxygen in the waters of New York Bay, generally in the year 1919, between the week of July 7th to 15th, and the two weeks of July 15th to 31st?

922 A. Primarily the biological activity that has taken place in those waters, resulting in the digestion of sewage and polluting matter, and the continuing reduction of the dissolved oxygen. Secondarily, the acceleration of those reactions, as the numbers of organisms build up and increase with the prolonged elevated temperatures.

Q. Have you the temperatures of the water recorded for these periods?

A. Yes, sir, they are recorded in the sheets numbered 1 to 6, the large table.

Q. Now will you refer to these tables which are supposed to have

been read into the record, and state the temperatures of the samples as taken from the waters and reported to you, assuming them to be correct for the purpose of this question, in the week of July 7th to 15th, and the weeks of July 15th to 31st, at Robbins' Reef, or at the station nearest to Robbins Reef.

A. That is Station 14 on my chart. On July 10th the temperature was 21 degrees, both top and bottom samples.

By Mr. McCarter:

Q. Is that Fahrenheit?

A. No, sir, that is Centigrade degrees. On July 14th the temperature at the surface was 19 degrees, and at 64-foot depth it was 18.

By Mr. Riker:

Q. That is a falling temperature.

A. Yes, sir, that is lower than the previous week. That is all up to the 10th.

923 Now, for the other period which you asked me, on July 17th, the temperature was 20 degrees at the surface, 19½ degrees at the 60-foot depth. On July 23rd, the temperature was 21, both at the surface and in the deep sample. On July 28th the temperature was 22 at the surface and 21 in the deep sample. And on July 31st the temperature was 22 at the surface, and 20 in the deep sample.

Q. Can you translate into Fahrenheit the temperatures that you have given?

A. Yes. 20 degrees is 68; 21 degrees is 69.8; 22 degrees is 71.6. There is 1.8 degrees Fahrenheit increase for each degree Centrigrade.

Q. Did you give 19?

A. 19 is 66.2.

Q. Do you consider those abnormally high temperatures for the water?

A. No; those are about normal for New York Harbor waters in this season.

Q. Then as I understand you, the large drop in percentage of dissolved oxygen from the second week in July to the end of the third or fourth week, is due to biological activity?

A. Yes, sir.

Q. How long does that biological activity continue?

A. Well, it continues right along. It speeds up with the warm weather and slackens down with cooler weather.

Q. Does it speed up during August?

A. I would expect it to speed up during August; yes, sir.

Q. And during September?

A. I would expect it to begin to slacken up, or just about
924 hold its own in September.

Q. And you think that this accelerated activity on the part of the biological life of the waters in New York Bay accounts for a drop in the dissolved oxygen from the second week in July to the end of the fourth week, of about 19 per cent, do you?

A. At the Narrows?

Q. In the average of the summer, the Narrows is 15; at Robbins Reef it is 18; at East River it is 14; at the Hudson River it is 19.

A. Yes, sir. Those figures are correct.

Q. And that is not abnormal?

A. No, sir; it is just what I would expect.

Q. What would you expect to be the falling off at the end of August?

A. I would not care to state any expectations. I would expect it to fall off somewhat.

Q. You have already said that these other figures are normal. Why wouldn't you be able to state what would be normal for August?

A. Merely that I can not do it.

Q. You have testified with reference to nuisances existing in waters where the dissolved oxygen has been reduced to a small figure, have you not?

A. Yes.

Q. Particularly the Passaic River?

A. Yes.

Q. And you said that Prof. Whipple had said that so long as there was any dissolved oxygen, there would not necessarily be a nuisance?

A. I do not recall quoting Prof. Whipple to that effect.

925 Q. How did you quote him?

A. I do not think I quoted him by name. I think my words were "It is contended."

Q. Then I will ask you, by whom is it contended?

A. I had in mind Prof. Whipple's testimony, and also I think that of Mr. Fuller in this case.

Q. Aren't you coming around practically to what I asked you?

A. No, sir, only I do not say I stated. You asked me if I stated and I said no.

Q. Will you quote as nearly as you can what Professor Whipple says on that subject.

(The witness refers to paper.)

Mr. McCarter: I suppose that we better have it from memory. We can read the evidence ourselves, I think.

A. I do not burden my memory with those things.

Q. You can not quote it?

A. No.

Q. Do you know whether he placed any limitations or qualifications around that statement?

A. Yes, I think he did.

Q. Did you incorporate those qualifications and limitations in your testimony on direct-examination?

A. I just definitely excluded all the limitations that I recalled he brought into play when I made the observations.

Q. Of what value is your testimony, then, if you remove all the qualifications that Prof. Whipple put around his statement?

926 A. You misunderstood my answer, sir. I meant to imply in my answer that I had properly taken into account the limitations.

Q. What limitations did you take into account?

A. I referred to his limitations that nuisance may sometimes be a phenomenon of bottom fermentation in the sludge, and not that of the water; and in my observations I was careful to take samples of the water in bottles and determine the odors in the water, so that I avoid any complication with odors that might be coming from the bottom in the form of large gas bubbles.

Q. Do you know whether or not there were sludge deposits at the bottom of the waters from which you took the samples?

A. I do not know. I assume from my general knowledge of such situations, that there were.

Q. Then the conditions under which Prof. Whipple testified, that no nuisance would exist so long as there was any dissolved oxygen in the water, is not disproved by what you found, are they?

A. I did not understand him to say that no nuisance would exist only under those conditions. I understood him to say that there might be a confusion in a condition arising from bottom deposits and that existing in the water.

Q. And that is what you base your testimony on, and your understanding of his testimony?

A. Yes; I endeavored to separate those two phenomena to determine whether there was an odor in the water, independent
927 of bottom conditions.

Q. How could you tell there was an independent odor in the water which did not come from the bottom conditions in the samples you took?

A. Because it was in the water after I took it away from the bottom.

Q. Is it not possible that the gases from the bottom were retained in suspension in the water that you took out as a sample?

A. Why, they might have been dissolved in water, but that does not comply with his restrictions. They were in the water, and the nuisance was arising from the water and not from the bottom.

Q. Is it not a fact that no nuisances are conceivable as existing in water from which practically the whole of the oxygen content has been removed?

A. No, sir, I do not think so.

Q. Is there any oxygen content in distilled water?

A. Yes, sir.

Q. How much?

A. Why, I can not say. It depends on how it is distilled. It may be saturated.

Q. It may also be entirely free from oxygen, may it not?

A. It would be possible to prepare the distilled water free from oxygen.

Q. Would it be free from nuisance?

A. Yes.

Q. How would you describe the condition of the waters in New York Bay, so far as you have determined it at the present
928 time, so far as the existence of nuisance is concerned?

A. On the ebb tide, I think there is a distinct nuisance in

the East River. Confining my answer to the main bodies of water, and not to the slips and inlets, the other waters of the harbor have not yet reached a condition of distinct nuisance. The Hudson River, however, is approaching such a condition more nearly each year.

Q. Do you distinguish between a distinct nuisance and an indistinct nuisance, or some other kind of nuisance?

A. Why, the word itself makes it necessary to qualify it, because we can have a gross nuisance or a slight nuisance. When I say distinct nuisances, I mean those that are noticeable to the ordinary man—distinctly noticeable.

Q. You think that a nuisance may exist that is not perceived by the ordinary man, do you?

A. Why, I think a chemist might in his odor examinations, report odors of putrefaction which, to the layman, would not appear on the surface of the water as a nuisance.

Q. Do I understand that you think that the word "nuisance" is a technical term of chemistry?

A. No, sir; I think it is a qualitative term which requires qualitative restrictions, if you are going to speak precisely about it.

Q. And when you attempt to qualify it by the word "distinct," you have your own idea of what is a distinct nuisance which may not conform to anybody else's, have you not?

929 A. I mean to express when I say "distinct nuisance," a nuisance which the average traveler on a ferry-boat would note.

Q. Now you think on the ebb tide that condition exists in the East River?

A. Yes, sir.

Q. And anywheres else in the harbor?

A. No, sir, I do not think so, except in the little inlets and places like Gowanus and Newtown Creek, which are really local matters.

Q. When did that nuisance develop, if you know?

A. You mean in years or during this year?

Q. In years.

A. I can not say that.

Q. When did you first observe it?

A. This summer.

Q. You never have observed it before that?

A. No, sir. I have had no occasion to make a careful examination of the river, or to travel on it before that.

Q. You have never crossed it on the ferry-boat, before that?

A. No, sir, I do not think I have.

Q. Now you have stated 70 per cent. of saturation as the safe saturation of oxygen of the waters of New York Bay, have you not?

A. On the average, for summer conditions, yes.

Q. 70 per cent. on the average for summer conditions?

A. Yes.

Q. What, if you know, is the highest percentage of dissolved oxygen in any harbor similar to that of New York?

A. Similar to New York?

930 Q. Yes.

A. I do not know of any harbor that is similar to New York in the extent of population sewering into it.

Q. What is the highest percentage of dissolved oxygen that you know of in any harbor?

A. I am not familiar with all the figures, but I think that question is so broad that one might say that values up to 100 per cent would be observed in some harbors.

Q. Do you know of any where there is dissolved oxygen of 100 per cent?

A. No, I do not know of any. That is merely because I have not examined for it. No doubt it exists. I am speaking of harbors that are not polluted.

Q. Why do you assume they exist if you do not know about it?

A. Why, it is a perfectly obvious thing, if they are not polluted—that is a law of physics.

Q. That they will become saturated 100 per cent?

A. Yes, and remain so.

Q. The waters of harbors?

A. Yes, sir.

Q. As a matter of fact, do you know of any water that is saturated to 100 per cent, except sea water, ocean water?

A. Yes, sir; I have seen many of them.

Q. Where?

A. I have seen the waters of the Potomac River super-saturated.

Q. Where else?

A. I have seen the waters of the Ludlow Reservoir, at the Springfield Water Supply in Massachusetts, 100 per cent saturated.

931 Q. What is the process of saturation of water by oxygen, mechanical or chemical?

A. I should describe it rather as physical.

Q. And just what do you mean by physical?

A. Merely that it comes in the domain of physics. That is the physical properties of things. Include solubility, and it has nothing to do with chemical properties, which relate rather to changes in composition of matter.

Q. Then it is not a chemical proposition?

A. The mere fact of solution is not a chemical process, no, sir.

Q. It is taken up by the action of the waves on the air, is it not, the oxygen?

A. The waves assist; they are not essential. Quiescent water will take up the oxygen.

Q. Do the waves assist materially in taking it up?

A. If the oxygen has been drawn down by pollution or fermentation, then the waves assist in reaeration to bring it back to normal. Normal, unpolluted, pure waters, however, are saturated practically as soon as they are formed, and tend to remain so.

Q. What is there about the waters of New York Bay which prevents reaeration?

A. Nothing prevents it. The effect of reaeration, however, is

reduced to very low figures, by the factors of depth, absence of violent agitation—that is all.

Q. As compared with the Ohio River, in what respects are
932 the waters of New York Bay inferior, in their ability to take up oxygen from the air?

A. They are much deeper, and in their deep portions are much more quiescent. The waters of the Ohio River are shallow, especially in summer time, when reaeration is most needed; they are dammed at frequent intervals, and flow over dams and at other points over rapids and shoals, so that they are thoroughly mixed and agitated to a degree which is impossible in a deep harbor.

Q. The expanse of the surface of New York Bay is considerable, is it not?

A. Yes.

Q. Considerable waves are produced by the action of the winds and currents?

A. Yes, sir.

Q. As compared with the open ocean is the depth greater or less in New York Bay?

A. In general, the ocean is deeper.

Q. Is the ocean water fully saturated?

A. Yes, sir, largely so, I believe.

Q. Is the water at the depth of the ocean quiescent?

A. Yes, sir.

Q. How do you account for the saturation of the ocean as compared with New York Bay?

A. In the first place, it has been there a long while, whereas the waters of New York Bay have their oxygen depleted, and they pass out within two or three tidal periods. There is no serious
933 deoxygenation taking place in the ocean, so that the very slow rate of reaeration which is present there is apparently sufficient to keep it oxygenated to a considerable depth. I have no doubt whatever that in such regions as the Sargasso Sea, or other areas where organic growths are prevalent, and there is decomposing organic matter at the bottom, that there would be found depletion of oxygen at great depths.

Q. As compared with the ocean, however, the rate of reaeration in New York Bay should be more rapid, should it not?

A. Not appreciably, no, sir; the actual reaeration as a factor is limited to the upper few feet, ten feet at the most. The rate of reaeration at greater depth than ten feet falls off very rapidly indeed, so that it is practically zero at 40 feet, and greater depths would make no difference whatever.

Q. Taking the upper surface to the depth you have mentioned, if the oxygen has been depleted in any way, is not the rate of reaeration greater than where the oxygen has not been thus depleted?

A. Yes, certainly.

Q. Would that be true of the waters of New York Bay?

A. Yes.

Q. Now when you fix an average of 70 degrees of saturation of

oxygen for the waters of New York Bay as a whole, what is the maximum saturation that you are assuming?

A. Well, the maximum would be 100 per cent.

934 Q. You are assuming that as existing anywhere in New York Bay, New York Harbor?

A. That we found actually existing in the water passing Sandy Hook. If you wish to include in your question the entire waters which we investigated—on the flood tide, waters that are practically 100 per cent come in by Sandy Hook.

Q. You took that as part of your data on which you made an average of 70 per cent?

A. Yes, in so far as that water came into the Lower Bay, that figured in the average values.

Q. What determinations did you take in determining 70 per cent as a safe average of the waters of New York Bay?

A. Well, that figure was actually arrived at by taking the entire amount of water which was variable with each tide, the incoming tidal flow, plus the flow of the Hudson River, which at that time had some oxygen—that is, it was about 70 per cent,—had some oxygen available—taking all of that water which had available oxygen and figuring the amount of sewage which that oxygen could take care of, down to 70 per cent, and having found that amount of sewage, we distributed that amount of sewage among the boroughs and among the different water courses in proportion to the populations which were found there, and upon that basis determined the actual condition of each of these tributary bodies of water; so that we started with our 70 per cent and then distributed it.

935 Q. You found 70 per cent at the time you made this determination, didn't you?

A. We started with that. That was our assumption.

Q. You started with it?

A. Yes, sir; that was assumed.

Q. And did you assume that as necessarily the minimum of the average saturation that was safe?

A. We assumed that that was the point that we ought to be allowed to work to, as a tentative assumption, and then we tried to show how that would come out.

Q. Why did you fix on 70 per cent?

A. It might be called a scientific guess at the start, until we saw how it would bring us out. I think perhaps that one thing that determined us was the report of the Bureau of Fisheries, which advised us that that was the limit for major fish life.

Q. Where did you find it?

A. That statement is made here without reference. It was obtained either by correspondence or from some printed documents of the Bureau of Fisheries.

Q. Do you accept that as the percentage of dissolved oxygen which will support major fish life?

A. Yes.

Q. On what do you base your acceptance of that?

A. Merely confidence in the author of it.

Q. Don't you know that numerous experts in this case have testified that they do not know the limits of oxygen required for the support of major fish life?

A. No, sir.

936 Q. You do not know that?

A. No, sir.

Q. Have you ever made any experiments to determine whether or not that is the limit—70 per cent?

A. No, sir.

Q. Ever made any experiments at all on that subject?

A. No, sir.

Q. So that when you fixed 70 per cent, you simply took a per cent that existed at the time you were making your determinations?

A. No, sir, you misunderstand me. I say that 70 per cent was purely an assumption, and a tentative assumption, as a basis for working until we could find out where that would bring us out. Now, if in the process of distribution that I have outlined, we found that the resulting depletion in these rivers was too high, and a lower limit was required, we would have cut down our initial assumption of 70 per cent because we would necessarily have to work our problem backward. We subsequently found out that that original 70 per cent gave us limits of the East and Hudson Rivers which were about as low as we could go.

Q. Could you not have determined, by the determination of the dissolved oxygen in the rivers and bodies of waters you referred to, as to whether or not they had reached a point of depletion that was dangerous?

A. This was not a question of whether they had at the present time reached such a point. It was a question of future policy for the guidance of the City authorities, and as to the probable

937 capacity of the harbor to receive sewage, and the probable result of the discharging of any specific amount of sewage upon the harbor. These conditions did not obtain in 1910. They had been reached and exceeded in the intervening time, however.

Q. In other words, the average oxygen content of the waters of the New York Harbor, has fallen below 70%?

A. Yes, sir.

Q. And you think that that has created a condition of danger, do you?

A. Yes.

Q. Whereabouts?

A. In the East River.

Q. Is that the only point?

A. Yes, sir, at present.

Q. Have you made any determination of the oxygen content of the waters of the Upper Bay near Governors Island?

A. Yes, sir, if by near Governors Island you will accept the mouth of the East River.

Q. How far is that from Governors Island?

A. I will have to refer to the map to get the exact distance (referring to map). From the point where our samples were taken at

Pier 10, East River, to the nearest point of Governors Island, is a little over half a mile.

Q. Pier 10 is almost down to the Battery, isn't it?

A. Yes, sir.

Q. Do you know where Red Hook is located?

A. Yes, sir.

Q. How far is Pier 10 from Red Hook?

A. It is a little over a mile and a half.

938 Q. Do you know what percentage of putrescible matter can be removed by fine screening from fresh sewage?

A. Shall I say Yes, or are you going to ask me how much? I will figure it, if you wish.

Q. Figure it, but I ask whether you know.

A. Yes, sir, I can determine it very readily, I think.

Q. Will you do so.

A. (Figuring:) 40 per cent by weight, and about 20 per cent. in terms of its putrescibility. That is, the matter removed is not so putrescible as the average matter.

Q. Now if you have the process of sedimentation, how much would be removed?

A. Well, my answer to the first question was based upon fine screening, which is not usually associated with sedimentation; and additional sedimentation after that fine screening would not remove much more—possibly another five per cent.

Q. Do you know whether it is contemplated to divert and discharge at or near Red Hook, 200,000,000 gallons of sewage a day from Brooklyn and the Brooklyn shores, and discharge it with treatment of sedimentation and screening?

A. Yes, sir, I have heard that plan described.

Q. Do you think that will be a safe disposal of 200,000,000 gallons of sewage a day, treated in that way?

A. I am puzzled over your use of the word "safe". I do not know what you mean by "safe treatment".

939 Q. You can not answer the question?

A. No, sir, not as put.

Q. Do you think the discharge of 200,000,000 gallons of sewage per day, treated by sedimentation, off Red Hook, will produce a local nuisance? Or are you troubled by the use of the words "local nuisance"?

A. No. sir; those words are quite plain. I think there might be a small local nuisance in the immediate vicinity of the discharge, depending upon the way in which it was discharged; but without further information as to just how it is to be discharged, I could not say.

Q. Would the discharge of 150,000,000 gallons of sewage a day at Robbins Reef, treated by screening and sedimentation, and discharged at a depth of forty feet, through multiple outlets, create a local nuisance, in your judgment?

A. I do not think there would be any serious local nuisance there.

Q. What do you mean by the word "serious"? I am troubled by the use of your word "serious", professor.

A. I mean a noticeable, objectionable condition immediately about the outlet.

Q. You do not think that there would exist any such condition as a serious local nuisance?

A. No, sir.

Q. What general effect would the discharge of two hundred million gallons of sewerage per day off Red Hook, treated by screening and sedimentation, have upon the general conditions of the waters
940 of the East River, the lower East River?

A. It would very much improve those conditions.

Q. Do you know in what direction the currents carry the surface waters from the point indicated off Red Hook?

A. Yes, sir, depending upon the tide, they go either way.

Q. Do they go at any tide, or any part of the tide up the East River?

A. Yes, sir.

Q. Professor, do you know that the methods of sewage disposal as now approved by the authorities of New York City, provide for screening of Manhattan shore of the Hudson River?

A. Yes, sir, I have been informed of that.

Q. And the discharge by submerged outlets into the current?

A. Yes.

Q. That for none of the sewage of Greater New York is any treatment suggested or planned beyond screening and sedimentation—do you know that?

Dr. O'Sullivan: The question is objected to, for the preceding witness distinctly stated that "tank treatment and other contemplated forms of refined treatment". I am using his own words.

The Commissioner: Note the objection of counsel for the complainants.

Q. Will you answer the question?

A. I do not understand that that is the case; no, sir.

Q. In what respect is the statement incorrect?

941 A. I understand from the testimony which I have heard here, and in my discussion with Mr. Allen and others, that other more extensive treatments are planned for certain areas.

Q. What further and more extensive treatment, and for what areas?

A. I heard Mr. Allen testify that the tank treatments were suggested for certain East River outlets.

Q. Is that anything but sedimentation—tank treatment?

A. I understood by your use of the word "sedimentation", something different from what we call tank treatment, which is in effect a prolonged sedimentation, with an opportunity to digest the sludge.

Q. Do you know that the tanks proposed provide for any long detention?

A. Yes.

Q. How long?

A. An hour and a half to two hours.

Q. Do you know what the detention provided for in the detention tanks of the Passaic Valley sewer is to be?

A. I am not certain; I would not testify from memory, but I have been informed it is somewhat less than that.

Q. Have you in mind the stipulation which is Complainants' Exhibit No. 135, with which I think you said you were familiar?

A. I said I was not familiar with the details of it. I have been in years past. My recollection is that that specifies the velocity. I do not recall that it specifies the time.

942 Q. I read from the stipulation: "Tank capacity shall always be such as to provide a detention period of not less than one hour at the maximum rate of flow at the sewer, and a detention period of the daily average flow of such sewage for not less than one hour and a half." Do you understand that any greater detention is contemplated in the tanks to which you refer as in an hour and a half?

A. Just what is your question?

Q. Didn't you hear it?

A. No.

Q. (Question repeated.)

A. Yes; I understood that two hours was planned in some of them.

Q. Which ones?

A. I can not testify definitely on that point.

Q. I am pressing you, because my recollection is that Mr. Allen said an hour and a half. What other treatment is provided or proposed, so far as you know, for the sewage of New York?

A. I understand that at Red Hook some further treatment, I do not know just what, is contemplated if and when necessary.

Q. Do you know the volume of discharge of sewage into the waters of New York Bay, and its tributaries at the present time?

A. No, sir, only in very approximate numbers. Volumes do not mean much to me in discussing these oxygen values. The population is the whole thing.

943 Q. I did not ask you whether they meant much. I asked you whether you knew. You do not know?

A. No, sir.

Q. Do you say it is less than 750,000,000 gallons a day?

A. I do not think I will guess at it. I said I did not know.

Q. Is it your opinion that the treatments as proposed for the sewage of New York City, will be sufficient to prevent local and general nuisances in the waters of New York Bay and its tributaries in the year 1960?

A. I doubt very much if it will.

Q. Do you know, or do you not know, whether the treatment proposed has been designed to provide sufficient treatment up to the year 1960?

A. I understand that the capacities and engineering design are based upon estimated population for 1930.

Q. Of how many?

A. I can not tell you. I do not understand, however, that the design is based upon the prevention of nuisance at that date.

Q. If Mr. Allen has testified that in his opinion it will accomplish that result up to the date of 1960, do you agree with him?

A. No, sir.

Q. Do you know whether or not these plans have been approved by the Chief Engineer of the City of New York, Mr. Lewis?

A. No, sir, I do not.

Q. Do you know Mr. Lewis?

A. Yes, sir.

Q. Now I return to the summary of 2814 examinations from 1909-1919, which is assumed to have been read into the
944 record, and ask you how you account for the increase of dissolved oxygen at the Narrows in the period June to November, 1915, as compared with the period 1914, June to September?

A. Why, I do not pretend to account for it. It is a fact, as far as we can determine. Seasonal conditions may have had something to do with it. The volume of flow of the Hudson River, the temperature of the water, possibly the distribution of the samples throughout the season was a little different in that year. The variations from year to year in that table in this report are not significant. The significant feature is that it has a general trend.

Q. What is the significance of the fact that appears here that in New York City at the Narrows from June to September, 1914, the dissolved oxygen was 68, and by your report of examinations, not made by you, from July 7th to 15th, 1919, at the same place, the dissolved oxygen is still 68—in 1919 as compared with 1914. Is there any significance to be attached to that?

A. No, sir, not in view of the entire table; the general trend is the significant thing, not the individual variations from time to time.

Q. Well, the general trend from 1914 to July, 1919, is nothing, isn't it?

A. I would hardly say so.

Q. Why, 68 and 68 are the same, aren't they?

A. I don't understand the general trend relates to two ends.

945 Q. Well, taking the intervening figures for the Narrows in 1915, the dissolved oxygen was 79, was it not?

A. Yes.

Q. And the next year, 1916, 64 per cent?

A. Yes, sir.

Q. And the next year, 1917, 63 per cent?

A. Yes, sir.

Q. 1918 it was up to 68 again?

A. Yes, sir.

Q. And in 1919 it remained 68, did it not?

A. Up to the 15th of July, after which it went down.

Q. Why do you give any significance to the drop between July 7th to 15th, and July 15th to 31st?

A. Because we had a series of three sets of analyses made that year, which not only in this station, but in three other stations all agree in descending regularly from May through July. The combined picture that is presented indicates a temperature effect.

Q. Well, taking 1914, and comparing it with 1915 at Robbins Reef, do you attach any significance to the fact that in 1915 the percentage was higher than it was in 1914?

A. No, sir, it was only one per cent higher.

Q. Then go back to another year—1913—do you attach any significance to the fact that the percentage then was 69 as compared with 72?

A. No, not in view of the showing of the entire column, I attach no significance to any comparison of single years.

Q. You do not attach any significance to the fact that in 1912 at the same points of the sampling which you have produced yourself, that that year the percentage was 64 at the same
946 point?

A. No, sir.

Q. During these years, 1912 to 1913 to 1914 to 1915, you have not enough of a series to determine that the oxygen content was improving at Robbins Reef from year to year?

A. I do not think that demonstrates any such condition.

Q. How far do you have to go to prove to your mind that result is obtained—until it is satisfactory to you?

A. I take all the available evidence, however far it goes. During those same years at the Narrows there was not any increase.

Q. Have you any reasonable explanation of the increase of the dissolved oxygen during those years, from year to year?

A. Why, I think they are probably due in part to the chance errors of sampling. They go out and take a small bottle of water out of this enormous Bay, which is not homogeneous, but a mixture. There is fresh sea water running under the polluted Bay water, and being churned into eddies and streaks of greater or less pollution, there is an inevitable error in all of our chemical work, which error we have got to eliminate in the only way possible, namely, by a study of the results from a large number of samplings. Those individual results are subject to a considerable error. In addition, from year to year we have seasonal variations and meteorological variations which also introduce changes and affect that particular season's work. But when we bring together enough of this
947 work, and compare the picture that is presented by a long series, and study the general tendencies, the significance of these little variations disappears completely.

Q. The population of the Greater City of New York tributary to the waters in question, was increased during the years mentioned, was it not?

A. Yes.

Q. Do you place any significance on the fact that at the Narrows in 1911, the dissolved oxygen was 79; in 1912, it was 79; in 1913, it was 72; in 1914, it was 68; and in 1915 it was again 79? How do you interpret that?

A. I have repeatedly stated that I place no significance on selected variations of this table taken away from all the other data, which is bound to influence my judgment.

Q. Was your judgment specially impressed in any way by the samples taken under your authority in July of this year?

A. No more than by any of the rest of them, in just so far as they form a part of the entire exhibit.

Q. So that you would place no importance upon the fact that between June, 1918, and July, 1919, the percentage fell ten points?

A. No, sir, I think that was a greater fall than is to be expected, in view of the whole table. It is not falling at that rate.

Q. You would not place any more importance on those two isolated determinations, if they had been sufficiently proved,
948 than you would from the fact that from 1917 to 1918 the dissolved oxygen at the Narrows increased from 63 to 68?

A. No, sir, not a bit.

Q. During what years do you understand, from such information as you have, that the largest number of samples were taken per year?

A. The largest number of samples, according to this table, appear to have been taken either in 1911 or 1913. I can not tell without adding them up. Shall I add them up, Mr. Riker?

Q. Yes, if you will.

A. In 1911, the largest number were taken, namely 851.

Q. Will you look at your summary and tell how the results appear to have been reached on that summary for the year 1911 compared with the other years that are included in the summary?

A. At the Narrows we have 79 compared with 83 for the year previous, and 79 for the year following.

At Robbins Reef we have 73 compared with 74 for the year previous, and 64 for the year following.

On the East River we have 54 compared with 65 for the year previous, and 50 for the year following.

On the Hudson River we have 61 compared with 73 for the year previous, and 57 for the year following.

Q. Now, taking the summary as a whole, what figures do you accept as the basis for your determination of the rate of decrease of the dissolved oxygen at the stations indicated on the sum-
949 mary?

A. In order to obviate as far as possible the accidental variations from year to year, I brought all of these results together in one grand average, which I read into the testimony this morning. That I think gives the fairest and best evidence of the actual conditions of New York Harbor from year to year. That, however, was expressed in terms of depletion, taking the 1909 value at 1.

Q. Determining the extent of the depletion how?

A. In terms of the 1909 value.

Q. What is the other limit, if you take the 1909 saturation and determine the depletion from saturation, above that?

A. I call that value 1. Now if it has a value twice as great as that, that is 2.

Q. Where do you find that value twice as great?

A. I read it into the testimony this morning. I can give you the figures again, or show them to you, if you wish.

Q. 1919, you set the depletion at 2.22, do you not?

A. Yes, sir.

Q. And that is based upon observation which you believe to have been made, and properly analyzed and determined as to oxygen in the three weeks of July 5th-7th, to 31st?

A. Yes.

Q. And you assumed that as a fair basis for determining the depletion from the normal of 1909?

A. I assume that the best basis that we have. I would
950 not attach any great importance to that particular figure 2.22, were it not for the fact that it forms a part of a fairly consistent series.

Q. Why didn't you take 1918 as the year for the determination of your depletion?

A. I did, I figured it from 1918 too.

Q. How much was it in 1918?

A. 1.88.

Q. How much was it for 1917?

A. 2.09.

Q. How do you account for the difference?

A. I have already gone into the matter very elaborately.

Q. I know; but go into it again.

A. These differences are accounted for by seasonal and meteorological variations from year to year; variations of the temperature, of the water, and the unavoidable inaccuracies of sampling a large body of water like New York harbor for chemical analysis.

Q. Then, for practical purposes, your determination of depletion percentages is of no value?

A. No, sir, I would not admit that for a minute.

Q. What value has it?

A. It has the greatest value.

Q. What value has the depletion of the percentages on the relations for the year 1917 and the year 1918?

A. They have value by themselves, but not such a great value as if they were supported by other data.

Q. In your opinion, was there less pollution in 1918 than there was in 1917?

A. No, sir.

951 Q. It is indicated by these figures, is it not?

A. It would be if those were the only two figures that we have. Were that the case, I would refuse to give any opinion on the data.

Q. In 1914, the figures are 164 as compared with 160 for the year 1915?

A. Yes.

Q. Standing by themselves, they would indicate less pollution in 1915 than in 1914?

A. They would not to me, no, sir.

Q. Standing by themselves?
A. No, sir.
Q. Why not?
A. Because I would not draw any opinion from those two years.
Q. How many facts must you have in order to draw any conclusion as between the two years?
A. Enough facts to give a consistent series of results.
Q. You would not be willing to express any opinion on the comparison of figures for any two years?
A. If the differences were great enough, I would; yes, sir. But if they were not so great but what I could explain the differences by accidental errors and seasonal variations, I would not.
Q. Where the differences exist between succeeding years, you assume, do you not, that there were accidental variations and seasonal differences?
A. I assume those variations and seasonal differences in all the data.
952 Q. Do you know of your own knowledge, whether there were variations and seasonal differences between the summer of 1917 and the summer of 1918?
A. Yes.
Q. Which would account for the fall of 1918? You do know it, do you?
A. Yes, sir.
Q. What were they?
A. Well, I know that no two years are alike in seasonal characteristics.
Q. What were the differences between those two years?
A. I do not recall those particular two years.
Q. You will observe from your table, will you not, Prof. Phelps, that the drop for the year 1919 of dissolved oxygen at the various stations that are referred to in this summary, is quite marked as compared with other years?
A. Yes, it is.
Q. How do you account for that?
A. By seasonal variations and accidental variations in sampling.
Q. And these samples, as you understand it, were not taken at the time of the maximum depletion of oxygen in the waters of New York Bay?
A. No, sir; I believe from the way they are running, that lower results would have been obtained this month. (August.)
Q. Is it your opinion that the seasonal differences between 1918 and 1919 have been greater than between any other two succeeding years, as laid out on this table?
A. I do not know that they have. I do not know just
953 what all those factors are which determine these variations, and it is impossible for me to say whether they are greater or less. I think that the results of this year are probably low. I would expect if we did this work again next year, that they might go up a little. I do not know, however. I believe that the results this year are accurate so far as we can make them accurate, and that

it really represents an abnormally low year, just as we have years of abnormally low water, low precipitation, low temperature, and other natural phenomena.

Q. The factors which tend to reduce the dissolved oxygen in bodies of water, I think you have testified, are temperature and precipitation. Are there any others?

A. Well, of course, the amount of pollution is a big one, but that is fairly constant. That is, the contributing population is really the determining thing. Of course, there are other things—the question of water which comes to us from up-river, whether one or another tributary to the Hudson, for instance, happens to be contributing the major proportion of the flow; even such minor matters as the chemical characteristics of the water undoubtedly affect its biological activity and contribute to variations from year to year.

Q. Now taking the two elements, however, the temperature and precipitation; has the precipitation for this year, up to the end of July, been abnormally low?

954 A. I do not know what it has been over the entire water-shed. I know it has been abnormally high in this area, but I understand that the wet spell did not hold over the Middle West; but I can not say that it held over the entire Hudson River watershed, or over the greater part of it.

Q. Do you know anything about it?

A. No, sir.

Q. Do you know how far it did extend up the Hudson?

A. No, sir.

Q. And over the shed drained by the Hudson?

A. No, sir.

Q. Has not the temperature been abnormally high up to the end of July?

A. The water temperature, or the air?

Q. The air temperature.

A. Speaking merely from my own personal observation, I believe the temperatures have been fairly normal for July.

Q. So that those two chief elements do not account for the very exaggerated depletion of the oxygen since 1918?

A. I would not wish to say that, because I said I did not know anything about the precipitation conditions; and naturally I can not form any opinion on it.

Q. My recollection is that in answer to complainants' counsel, you said that the precipitation had been great, didn't you say that?

A. Yes, I said I spoke from my own impressions. I do not know how far that extends over the water-shed.

955 Q. So far as you know, has there been any abnormal increase in the growth of population between 1918 and 1919?

A. No, sir.

Q. Do you have any knowledge of any chemical conditions that exist in 1919 which did not exist in 1918?

A. No, sir.

Q. Which might account for this great change?

A. No, sir, I have no knowledge of such a thing.

Q. That is only a scientific guess?

A. You asked me what might explain those results, and I suggested the various things that do affect the results.

Q. You appreciate that it is part of complainants' case to show the dissolved oxygen in the waters of New York Bay and its tributaries at as low a point as the facts will warrant, do you not?

A. No, sir, I do not understand that to be the purpose. It is certainly not the purpose of my investigation.

Q. (Question repeated.)

A. The facts only warrant one showing. I do not see how there can be any variation from that.

Q. A partial sampling, Professor, is not an accurate gauge of the actual dissolved oxygen in the water, is it?

A. A partial sampling?

Q. Yes.

A. You mean selecting sample stations?

Q. Would you call sampling during the weeks of July 7th and July 31st as a partial sampling of the waters of New York Bay?

955 A. For the year, yes, sir. It would not be for that period.

Q. Do you think that the number of samples taken, as you understand they have been taken, and the oxygen determined, is anything more than a partial sampling during that period?

A. I think it is a very complete sampling during the period of July 7th to 31st.

Q. How many samples were taken?

A. 290.

Q. Extending over 24 days?

A. Yes, sir.

Q. You think that is a complete sampling?

A. Very complete for that period.

Q. You testified that on the evidence of Prof. Whipple, or Mr. Whipple, the dissolved oxygen in 1919 exceeded the dissolved oxygen in 1909, did you not?

A. I do not think I testified on that point. I think he did. That seems to be the case.

Q. Taking the Narrows, for example, in 1909, the dissolved oxygen, as stated on your summary, was 78 per cent, according to Prof. Whipple, and in 1919 was 76 per cent. That is not greater, is it?

A. No, sir, that is less.

Q. And in the Hudson River in 1909, 67 per cent; and in 1919, 68 per cent. That is one point higher, is it not?

A. Yes, sir.

Q. Taking it altogether, however, you find that there is an increase indicated on his returns for 1919 as compared with 1909?

A. Yes, sir, the figures are slightly higher.

957 Q. Is that accounted for by the different months of the year in which they are taken?

A. I think that would undoubtedly affect the result. I do not know whether it accounts for all of it or not.

Q. In the same waters which would be the higher, for the month of November or the month of May, in any year?

A. I would expect the month of May to be higher.

Q. The sampling for 1919 was done in May by Mr. Whipple, was it not?

A. Yes.

Q. And in 1909, in November?

A. Yes.

Q. Now you have testified that in your opinion there exists a nuisance in the East River. In what does that nuisance consist?

A. Marked discoloration of the water; evident turbidity of sewage origin, and noticeable odors on certain stages of the tide.

Q. What is the color that you have observed in this water which you say constitutes a nuisance now?

A. Why, it is black. It is the color one would obtain by putting a little ink in water; it is a blackening of the water.

Q. What is the origin of that color, if you know?

A. Decomposition of sewage, the formation of some sulphides which are black.

Q. Any part of it due to the discharge from gas houses?

A. No, sir, I do not think that blackening was at all due to gas-house discharge.

958 Q. Did you observe any gas house discharges in the river?

A. No, sir.

Q. Because there are none, so far as you know?

A. I have no doubt there are plenty of them. I did not observe the effect of them, at all.

Q. How did you happen to observe the nuisance in the East River, which you have described?

A. I went out there to see if there was any.

Q. What did you go in?

A. A boat.

Q. What kind of a boat?

A. Small launch, a 30-footer, I think it was.

Q. How far out of the water were you seated?

A. Oh, it was a little boat. My head was within three feet of the water when I was seated.

Q. The nuisance that you complain of consisted of discoloration and an odor. Anything else?

A. Turbidity.

Q. How did you distinguish between turbidity and color?

A. Why, they have very distinct meanings. Color is to a water chemist what a cup of tea has; and turbidity is what poorly made coffee has—that is, muddy. That is, turbidity prevents one seeing through the sample, but the color does not render the sample opaque.

Q. Has turbidity any color?

A. Yes, it sometimes has color. That is referred to sometimes as the apparent color.

Q. Turbidity is due to what?

A. Turbidity that was most noticeable in the East River
959 during the month of July was distinctly of sewage origin. One accustomed to observe these things can quite readily distinguish that from normal turbidity, which is seen in the Hudson River during the spring, for instance, and which is merely washed from the drainage area.

Q. Did the nuisance that you observed, so far as you know, affect any other person than yourself?

A. Do you mean was it observed by others?

Q. Yes.

A. The odors were discussed by the party on board, and all agreed that sewage odors were noticeable on certain days.

Q. That was by the party who were making the trip for the purpose of observing these conditions and determining whether a nuisance existed or not?

A. Yes.

Q. You do not know of it having been observed by anybody else, do you?

A. No, sir, I have not discussed it with others.

Mr. Riker: You may re-examine, Dr. O'Sullivan.

Redirect examination.

By Dr. O'Sullivan:

Q. Prof. Phelps, in reply to some questions put to you by Mr. Riker, you stated that there were fluctuations in the oxygen content in the waters of the Harbor from one year to another; is that so?

A. Yes, sir.

960 Q. Is it or is it not a fact that during the spring freshets sludge deposits in the pockets of the Hudson River are brought down in these freshets and deposited in the Upper Bay of New York during the spring months, and during heavy precipitations?

A. That is a fact of common knowledge in any river.

Q. You were asked by Mr. Riker as to what you base your estimate of 70 per cent of oxygen content as being necessary to the sustenance of major fish life, and I understood your answer to be that you based that upon the direct series of investigations conducted by the Bureau of Fisheries?

A. Yes, sir.

Q. And you were asked whether or not other experts who had testified, stated that they did not know. Do you regard the positive, direct experimental discovery of that percentage as superior to the negative evidence of men who merely state they don't know?

A. I certainly do, yes, sir.

Q. I understood you to reply to Mr. Riker that you would need a considerable number of samples in order to base conclusions or deductions as to whether depletions of oxygen content in our harbor waters was progressing or merely fluctuating?

A. Yes, sir.

Q. I hand you Defendants' Exhibit 8, and direct your attention particularly to the two samples taken by Mr. Whipple on May
961 3rd, 1919; one at the surface, what does that show the percentage of oxygen, Station L?

A. 45.2 per cent saturation.

Q. And at the same location, what does the 60-feet-deep sample show?

A. 86.9.

Q. Almost twice the oxygen content in the deep sample that he found in the surface sample, at the same idential location; is that a fact?

A. Yes, sir.

Q. Does that seem to sustain your view that a number of these samples, to avoid any casual errors of that kind, should be submitted before an opinion should be based upon it?

A. That illustrates very well the variability of the sampling, and the necessity of averaging the large series of results before drawing conclusions.

Q. And that those samples were both taken in the Narrows where the refreshing flood waters were coming in?

A. Yes, sir.

Dr. O'Sullivan: That is all.

Mr. Riker: No more questions.

(Whereupon, an adjournment was taken to Tuesday, August 12th, 1919, at 10:30 o'clock a. m.)

962 Municipal Building, New York City,

August 12th, 1919, at 10:30 a. m.

Present: Parties as before noted.

The Commissioner: Pursuant to adjournment, the hearing is resumed.

OLIN H. LANDRETH was called as a witness, and having been duly sworn, on behalf of the complainants, testified as follows:

By Dr. O'Sullivan:

Q. What is your full name, Prof. Landreth?

A. Olin H. Landreth.

Q. What is your occupation?

A. I am a civil engineer.

Q. Have you held a teacher's position in the engineering profession?

A. I have, at two different institutions.

Q. What status, what title?

A. I was for fifteen years Professor of Engineering at Vanderbilt University, Nashville, Tennessee, and for the latter seven or eight

years of that period I was also the Dean of the Engineering Department of the University. I resigned that position to accept a similar position at Union College, Schenectady, New York, where I was for
963 23 years Professor of Civil Engineering, and head of the Engineering Department, and was for two years Professor of Engineering Practice. I have now resigned from Union College, and am Emeritus Professor of Civil Engineering.

Q. Are you now in private practice as a consulting engineer?

A. Yes, I am.

Q. Where did you receive your professional education and training?

A. Both from experience in practice, and from a formal course of study at Union College Engineering School at Schenectady, New York.

Q. And what degrees did you take at any of these professional institutions?

A. I took at first the degree of Civil Engineer.

Q. Where?

A. The Engineering School in Union College.

Q. In what year?

A. In 1876. I then remained to complete what I had been carrying on, the course of study leading to the degree of Bachelor of Arts, and completed that course in 1877, and received the degree of Bachelor of Arts. Later, the institution conferred on me the degree of Master of Arts, and later, the degree of Doctor of Science.

Q. State what education and experience you had in astronomical and geodetic matters?

A. After leaving college in 1877, I was for two years Assistant Astronomer at Dudley Observatory, at Albany, New York, where I was in charge of two distinct lines of work; time determination and distribution throughout the State of New York, which
964 service had not then been undertaken by the Naval Observatory at Washington. I was also in charge of the Equatorial Department and Equatorial instruments with observations in that department.

During that period I was also sent in charge of an expedition to the Belderberg Mountains, to observe the Transit of Mercury, in 1878.

In 1882, while at Vanderbilt University, I was placed in charge of the observatory during the period of the preparation for and observations of the Transit of Venus, of that year; and the observations were taken and reduced under my immediate direction.

During th summers of 1882 and 1883, that is, three months, summer vacation, I was Aid on the New York State Survey, and was in charge of the laying-out of the primary triangulation for that survey.

Q. What engineering experience, Prof. Landreth, have you had?

A. I began my engineering experience in 1869 or 1870, as stake-driver on what is now the Lehigh Valley Railway between Geneva and Naples. I occupied various positions in that survey, and in other subsequent surveys, of chainman, rodman, transitman, leveler,

division engineer. The latter positions were occupied on the
965 Rochester, Hornellsville Pine Creek Railroad, later changed to the New York & Pennsylvania Railroad; and also on the Erie Railroad. During the years 1874-1877, I made surveys, investigations and estimates for water supply and water works at Schenectady, New York, and at Olean, New York. I also conducted a series of investigations extending through a year at Schenectady on the matter of underground temperatures, their extent and variation throughout the year.

From 1881 to 1891, I was Superintendent of Grounds and Buildings at Vanderbilt University, Nashville, Tennessee, and as such was in charge of the water supply, sewerage, central steam heating system, and new buildings, and had occasion to design three or four large university buildings and five or six dormitory buildings. During that period I made surveys and estimates for a line of railroad from Kingston, Tennessee, to Harpeth River "Narrows," Tennessee, and in connection with that made a survey, investigation and report on the water power at Harpeth River "Narrows." During that period I also made surveys and estimates for a line of railroad from a point on the Nashville, Chattanooga & St. Louis Railway in Lewis County, Tennessee, to the Maney Mines, which road was built, and is now operated, on the lines of the survey made by me. I also during that period made plans for a system of water works at Fort Valley, Georgia. Also the plans for a system of water works and electric light at Crowley, Louisiana.
966 I was also Consulting Engineer of the water works and electric light at Union City, Tennessee. I was also Consulting Engineer on the water works at Morganfield, Kentucky. In 1883 and 1884, I made surveys and investigations of the old water-works system for the City of Nashville, Tennessee, and made recommendations as to the temporary improvements in the same pending the design and construction of a new system of water supply for that city.

From 1883 to 1885 I was Consulting Engineer to the City of Nashville Board of Public Works, and as such made surveys, investigations, general plans and recommendations for an entirely new system of water supply for Nashville, costing between one and two million dollars.

In 1886, I was Consulting Engineer on the Cumberland River Bridge at Nashville, Tennessee, costing upwards of $130,000.

In 1887, I was Consulting Engineer to contractors and for them made plans for laying a very different piece of submerged 48-inch cast iron intake main under the Cumberland River extending from the Nashville pumping station along the bed of the river for about 2,000 feet, to the intake tower. I was also Consulting Engineer to the West Nashville Water Company on surveys and designs for new system of water supply. I was Consulting Engineer and reported on a proposed "cut-off" water-power canal across
967 "Moccasin Bend" in the Tennessee River at Chattanooga, Tennessee.

I reported in favor of the abandonment of the plan, which recommendation was adopted.

I was engaged by the Tennessee State Board of Health to investigate and report on the matter of "Smoke Prevention" for the State.

I was also engaged by the Tennessee State Board of Health to investigate and report on the "Probable Sanitary Effect of the Proposed System of Government Locks and Dams on the Cumberland River.

I was appointed Special Commissioner for the Tennessee State Board of Health to examine and report on the Sanitary Engineering Features of the World's Fair at Chicago, in 1893.

From 1893 to 1906, I was Consulting Engineer of the New York State Board of Health, and of the New York State Department of Health, the former Board having been re-established into a distinct department during that period.

Under that engagement my duties included, among other things, the formulation of rules and regulations for the sanitary protection of water supplies of the State, and I prepared such rules for upwards of twenty cities and towns in the State. Among those were: Elmira, Utica, Auburn, Binghamton, Geneva, Saratoga, Troy, Rome, Little Falls, Syracuse, and other places.

968 I also made, under such engagement as Consulting Engineer of the State Board of Health, upwards of one hundred special investigations and reports on important sanitary matters at different places throughout the State. This list included an investigation of the typhoid epidemic in the City of Elmira, in the year 1896.

An investigation of the typhoid epidemic in the City of Ithaca.

An investigation of the typhoid epidemic in the City of Watertown.

An investigation of the pollution of Saratoga Lake from the sewage of several towns, including Saratoga and other places, and also from a number of industries including the refuse from the Union Bag and Paper Company's paper mills, large tanneries, and other industries situated on streams tributary to Saratoga Lake.

I made an investigation of the pollution of Owasco Lake, which is one of the finger lakes in the central part of New York State. This investigation was made because of the fact that the City of Auburn had been taking its water supply from that source, and it was about to enlarge its supply, and desired to ascertain whether the pollution of the lake was such as to render the lake a suitable or unsuitable source of supply, and also whether the exist-

969 ing pollution could be remedied or reduced. That investigation led to extensive negotiations with different municipalities, and ultimately to litigation which resulted in the stopping of the pollution from a number of those points of pollution, particularly villages on the tributary streams entering the lake. Under that engagement with the State Department of Health, I also made an investigation of the pollution of Lake Champlain, particularly with reference to the pollution coming from manufactur-

ing industrial systems situated on tributary streams, and the investigation led to negotiations and later, the beginning of litigation, which in turn led to the removal of pollution from the lake by the largest source of industrial pollution, and the inception of methods of diverting and utilizing the industrial waste which had been the cause of the pollution from that establishment.

I also made for the State Department of Health, an investigation of refuse discharged from manufacturing establishments generally on the Upper Hudson and Mohawk drainage areas, as a result of which the New York State Law for the Regulation of the Discharge of Sewage and Manufacturing Wastes into Streams was enacted, and is now in force. Under this engagement I also made plans for water supply and for sewerage and sewage disposal for a number of state institutions, under the general direction
970 of the State Architect. These included a system of sewage disposal at the Newark Custodial Asylum; also for a system of sewage disposal for the Western House of Refuge for Women at Albion, New York; also for the House of Refuge for Women at Hudson, New York; also for the State Tuberculosis Hospital at Saranac, or between Saranac and Lake Placid, New York; also for the Albany Tuberculosis Hospital, at Albany.

I have been called in by a number of municipalities and corporations on sanitary engineering matters, including Cuba, New York, where, under private engagement, I prepared plans for the entire sewerage of the town and for a system of sewage disposal work; also complete plans for a system of sewerage at Saranac Lake, New York; also for a complete system of sewerage for the Village of Norwood, New York; also for Dolgeville, New York. I was Consulting Engineer on the system of sewerage and sewage disposal at Batavia, New York. I was called in as the expert in an investigation of the causes for an extensive ice jam at Herkimer, New York, on West Canada Creek, which ice jam caused a flood which did very extensive damage in the city.

I was called in by the authorities of Lyons, New York, to investigate a serious sanitary situation, involving sewerage and drainage in that town, and made recommendations which, when car-
971 ried out, gave relief.

I was called in as an arbitrator in a dispute between the authorities of the City of Oneida, New York, and contractors who were building a sewer system for that place. I was retained by the City of Gloversville, New York, on several matters involving city improvements, including drainage.

I was called in by the authorities of Johnstown as Consulting Engineer, and as such also prepared plans for a revision of the sewer system, the installation of a trunk sewer, and the disposal of the sewage of that city.

I was called in by the authorities of the City of Poughkeepsie, New York, to investigate and report on a phase of the water supply of that city.

I was engaged by the City of Oswego, New York, as Consulting Engineer in charge of the planning of a new system of sewerage and

sewage disposal for both portions of that city, East Oswego and West Oswego, which called for two entirely distinct systems supplying the opposite sides of the Oswego River, which systems have been partially executed, and have been executed as fast as municipal funds are available.

I was called in by the City of Syracuse, New York, to consider the question of its water supply, which was then being taken
972 from Skaneateles Lake, and which was threatened with pollution entering the lake, which investigation led to the formulation of rules and regulations for the protectoin of that water supply, and led to negotiations between the City of Syracuse and various owners on the lake, regarding the abatement of the pollution of the lake.

I was called in by the City of Geneva, New York, to investigate and report on a situation in its water supply.

I was called in by the City of Schenectady, New York, to advise the city in connection with the preparation of a contract between the City of Schenectady and the General Electric Company, by which the latter company should furnish the pumping facilities for pumping the city's water supply, and under such engagement made investigations and tests of the pumping plant and report.

I was also called iff as an expert in litigation against the City of Schenectady by adjoining property owners to compel the abatement of a nuisance produced by its sewage disposal plant, which was recently constructed. This litigation led to an opinion by the Court that the conditions did constitute a nuisance, but suspended the issuing of the injunction until the City should have opportunity to abate the unsanitary conditions, and the nuisance which existed.

I was called in by the City of New York as an expert in
973 litigation against the City for an injunction against some Staten Island sewers, in which the City successfully defended its position.

Q. Prof. Landreth, have you had any experience in hydraulic engineering, and if so, state to what extent?

A. I was called in by the authorities of the Village of Nunda, New York, to investigate and report on a matter of water power and its relation to the city water supply in that town. I was engaged by a private corporation to investigate that corporation's water rights on the Mohawk River at Rexford Flats, and reported on that investigation.

I was also retained by the Johnstown Electric Light & Power Company on two occasions; first, to serve as an expert in a suit for injunction against the company for the alleged improper detention and discharge of water through its water power plant. I was also later engaged by the same company to prepare plans for a radical alteration and enlargement of its water power, which plans were carried out.

I was retained by the City of Johnstown, as an expert in the valuation of ten water power properties, which had been wholly or partially condemned by the City in the taking of its sources of water supply from streams on which those powers were situated.

I was retained by the City of Gloversville, New York, for similar valuations of water powers, situated on the streams whose
974 waters had been appropriated by the City of Gloversville.

I was retained as expert by the City of Ithaca in the valuation of its water works, on condemnation proceedings by which the City had acquired its water system from a private water company, which was the original owner of the system.

I was retained by the Town of Glenville, as expert in an action brought against the State of New York for the destruction of its highway bridge across the Mohawk River, due to floods in the river, caused by the building and improper use of the State dam at Vischer's Ferry, which established the liability of the State for the flood, and gave the town compensation for the bridge destroyed.

I was retained by fifteen or twenty different corporations owning water powers which had been appropriated by the City of Troy, New York, in the enlargement of its water supply.

I was retained in five or six different condemnation proceedings, which were instituted to determine the value of water power at Esopus Creek, the waters of which stream had been appropriated by the City of New York for its Catskill extension to the New York water system.

I was retained by the City of New York on a water power valuation on the East Croton Branch of the Croton water supply,
975 which stream had been appropriated by the City of New York.

I was retained by the State of New York on the valuation of certain water-power properties appropriated by the State in the construction of the Barge Canal, on the Oswego River at Fulton, New York; on the Seneca River at Seneca Falls, New York, and on the Oswego River at Oswego, New York.

I was retained as expert by the United States, in the case of the United States against the Sanitary District of Chicago, on the diversion of water through the Chicago Drainage Canal, and I am still an expert in that case.

During the years 1902 and 1903, I was a member of the New York State Water Storage Commission on floods and their Prevention, in streams, throughout the State of New York.

From 1903-6, I was a member of the New York Bay Pollution Commission, the purpose of which Commission was to investigate the then threatened alleged pollution of New York Harbor by the contemplated Passaic Valley Sewerage system. That Commission was constituted by the Legislature of the State of New York, and among its duties was prescribed an effort to ascertain if co-operation between the two states could be reached, as to a means which should avert the threatened pollution and should remedy the existing pollution of the harbor from various sources.

976 From 1906 to 1908, I was a member of the Metropolitan Sewerage Commission of New York, the purpose of which was also, in part, to ascertain if co-operation between the two commonwealths was feasible as a means of providing either conjointly or by co-operation, a systematic means for the averting of the future

threatened pollution of the harbor and the reduction of the existing pollution.

I was a delegate from the State of New York in 1906 or 1907, to the National Irrigation Congress, at Spokane, Washington.

I was a delegate to the New York State Constitutional Convention of 1915, and member of the standing committees on canals and also on conservation.

I was engaged to make a valuation of a portion of the Delaware & Hudson Railroad Company property between Schenectady and Saratoga.

I was engaged to make a valuation of a portion of the West Shore Railroad Company property between Little Falls and St. Johnsville.

In 1918 I was appointed Mechanical Engineer in the United States Ordnance Department at Washington, Serving in the Estimates and Requirements Division, Progress Section, Instruments and Gunfire Control Branch.

I am at present engaged on an investigation for the Merchants Association of New York, on the collection, transportation
977 and disposal of garbage and refuse of the five boroughs of the City of New York.

I am also acting at present as Chief Engineer of the Eastern Potash Corporation, in the development of a new process for producing potash from American sources, and in the design and construction of a $2,000,000 plant for the production of potash by that process, in the State of New Jersey.

Q. What memberships do you hold in learned and technical societies, connected with your profession?

A. I am a member of the American Society of Civil Engineers, and by reason of my length of membership, have now become a Life Member, and was also a director of that Society from 1893 to 1896.

I am a member of the American Society of Mechanical Engineers, and by reason of my length of membership, have become a Life Member also in that Society, and was the Vice-President of that Society for 1883.

I am a member of the Society for the Promotion of Engineering Education, and was a member of the Council of the Society from 1893 to 1896, and again from 1901 to 1904.

I am a Fellow of the American Association for the Advancement of Science and was Chairman of the Section on Mechanics and Engineering for the year 1892.

I was for some years a member of the American Public
978 Health Association, and was a member of the Standing Committee on Refuse Material for 1902 and 1903. I was one of the charter members, and during my residence in Tennessee, was Secretary of the Engineering Association of the South, which is now the leading technical society of the Southern States.

I was a member of the Schenectady Technical Association and was Vice President in 1895-1896, and was President in 1896-1898, and instrumental in the reorganization of that Society into the

present Society of Engineers of Eastern New York, of which also I have been Vice President and President.

I was for a number of years, a Member of the American Society for Testing Materials.

I am a member of the Sigma Xi Society, of the Union College Chapter, and was President from 1900 to 1904.

I am a member and director of the Schenectady Board of Trade, and a member of its Standing Committee on State Affairs.

I am a member of the Merchants Association of New York, and of its Standing Committee on Inland Waterways and Canals.

I am a member of the New York State Waterways Association, and a member of its Executive Committee.

I was a member of the Advisory Council of the Engineering Congress, at the World's Fair, Chicago, in 1893.

979 Q. Prof. Landreth, what familiarity have you with New York Harbor and adjacent waters thereto?

A. My acquaintance with New York Harbor dates from 1896, at which time I commenced my duties as Consulting Engineer of the State Department of Health of the State of New York. My duties as such Consulting Engineer, have frequently led me to New York and adjacent points, and gave me the opportunity to investigate, or at least to observe and examine the then condition of New York Harbor, as a part of my studies and investigations of the pollution of streams throughout New York generally, which investigation I have already referred to. My connection with New York Harbor took more formal shape when I was appointed a member of the New York Bay Pollution Committee, the particular purpose of which was to investigate the condition of New York Harbor. That opportunity for inspection and observation was continued by my membership in the Metropolitan Sewerage Commission of New York, which extended to 1908, before which time, and up to the present time, I have been associated with New York in its efforts to avert the pollution of the river coming from the proposed Passaic Valley trunk sewer, and in efforts to bring about a reduction of pollution produced from the New York side. In such connection I have made numerous and frequent examinations and trips over various portions of the waters, having examined, I guess,

980 every single portion of the Harbor and its adjacent waters, some of them on many occasions.

Q. Have you studied Complainants' Exhibit No. 135, being the stipulations entered into between the Federal Government and the State of New Jersey, and the Passaic Valley Sewerage Commission?

A. I have.

Q. State what the results of your studies and examinations of that exhibit have been.

Mr. Riker: The question is objected to as calling for an answer not within the scope of the order of March 10, 1919.

Dr. O'Sullivan: The question is pressed, as the order distinctly desires to have added information relative to additions to the provisions therein made for diminishing the polluting effect of the effluent to be discharged from the Passaic Valley trunk sewer.

The Commissioner: Note the objection of counsel for defendants.

A. The results of my study of that exhibit have led me to conclusions formed long ago when that stipulation was first offered, that it was inadequate to properly protect the interests of New York, particularly its sanitary and property interests, as distinct from navigation interests, from the threatened pollution from the Passaic Valley Sewer System.

981 Q. Have you read the Order of the Supreme Court of the United States, dated March 10, 1919, in relation to this present litigation?

A. I have.

Q. Have you made a personal inspection of the Passaic Valley Sewage Disposal Plant?

A. Yes; a partial inspection. That was made on July 30th, in company with several of the gentlemen from New York as guests of the Passaic Valley Sewerage Commissioners, or the Engineers of that Commission.

Q. Will you state what that inspection consisted in?

A. It consisted in an inspection of the pumping station as at present constructed; the detention basins, as at present constructed, and also in inspection of the sections of the conduit pipe and nozzles, which are being installed at the dispersion area of the Passaic Valley Sewerage Commission near Robbins Reef, in New York Bay. We had no opportunity to examine plans, but we saw——

Mr. Riker: You did not ask to, did you?

The Witness: Yes. There were several features which could have been shown by the plans, and we were not shown the plans.

Mr. Riker: The question calls for the conclusion of the witness.

982 Q. Who accompanied you, Prof. Landreth, on your tour of inspection of the Passaic Valley Sewage Disposal Plant on July 30th, 1919?

A. From New York?

Q. Yes.

A. The Assistant Attorney General, Dr. William J. O'Sullivan, Dr. Earle B. Phelps, and Mr. Kenneth Allen, both the latter of whom are experts from New York, in this present hearing. At Newark we met Mr. Brown, the Chief Engineer of the Passaic Valley Sewage Commission, Mr. Taylor, and Mr. Van Duyne.

Q. Who were these two latter gentlemen?

A. They are both engineers under Mr. Brown, on the Passaic sewerage system. These gentlemen conducted us to and through the pumping station, the detention basins, and to the work being done on the shore, the dispersion area near Robbins Reef.

Q. Prof. Landreth, from your acquaintance with the waters of New York Harbor in 1908-1910, did you form at that time any definite opinion as to the character and the degree of the pollution of the waters of the harbor at different characteristic points in the harbor waters?

A. I did.

Q. From your acquaintance with the waters of the harbor, have you formed a definite opinion as to the character and degree of pollution of the waters at these characteristic points at the present time?

A. I have.

Q. Have you been familiar with the waters of the harbor and formed definite opinions regarding the quality of the waters, and their degree of pollution at different times between 1909 and the present time, 1919?

A. I have.

983 Q. Has the character of the waters of the harbor and their degree of pollution undergone, in your opinion, any material change in the interval of time between 1909 and the present time, and if so, will you please state what is your opinion as to the character and extent of such changes.

A. Passing over at first the seasonal variations, both periodic and irregular, and passing over changes in quality at different characteristic points in the harbor, it may be said that the waters of New York Harbor have clearly undergone a progressive impairment in quality and an evidently decided increase in degree of pollution, during the period referred to.

Q. To what have you reference when you speak of seasonal variations, both periodic and irregular?

A. By periodic seasonal variations, I refer to the change in character of the waters of the harbor throughout an ordinary year. Notwithstanding the fact that the quantity of polluting matter which is being discharged into the harbor remains substantially constant the year round and has no seasonal periodic change, but only a progressive increase year by year, it is nevertheless the fact that the resulting pollution of the waters of the harbor does undergo a wide range in variation throughout the year. The production of disagreeable odors, the turbidity of the waters, and the presence on the surface of the water of foul-smelling and obnoxious floating

984 organic materials very largely affected by the seasonal temperature, and also by the degree of dilution produced by the volume of fresh-water discharge from inland streams. Since both the seasonal temperatures and the degree of fresh water dilution have wide annual periodic variations, and since the causes favorable to pollution, namely, the high temperatures of summer and the minimum discharge of fresh water streams occur at the same time; and since the factors unfavorable to pollution, namely, the low temperatures of the year, as well as the increased fresh-water dilution, all occur during the fall, winter and spring months, there results the well-defined periodic change in pollution which attains a maximum toward the end of the heated season of the year, and a minimum toward the end of the cold season of the year.

By the irregular seasonal variations I refer to the differences between one season and another. Thus, one season may have very moderate summer temperatures and ample rainfall and fresh water discharge from the drainage area, as we have had in this present

year, 1919, and another season may have a similar combination of unfavorable conditions, that is, conditions favorable to pollution.

Q. To what do you refer when you speak of different characteristic points in the harbor?

A. I refer to the well-known fact that all points of New York Harbor and adjacent waters are not equally polluted. The
985 actual resulting pollution at any point in the harbor is greatest where the quantity of foul polluting material discharged is the greatest and where the opportunity for dilution or dispersion by both fresh and tidal currents is the least. These factors favorable to pollution exist and concur very differently at different points in the harbor. Thus, the dock slips, Gowanus Bay and Canal, Newton Creek, and to a lesser extent, the Harlem River, are characteristic points of dense pollution, while points farther removed from the sources of pollution and nearer to the sources of diluting water such as the lower Bay, the North River above Spuyten Duyvil, the East River near Throggs Neck, are less seriously polluted.

Q. To what do you attribute the year-by-year progressive impairment in the quality of the waters of the harbor and their progressive increase in pollution?

A. To the fact that the capacity of the harbor waters to satisfactorily dispose of sewage is a fixed quantity which can not be increased, whereas the quantity of sewage being discharged into the harbor is constantly increasing year by year as population and industries increase. We are accumulating, by large annual increments, a cumulative deficit in the form of an accumulation of putrescible sewage sludge deposited on the bottom of the harbor
986 and the products of putrefactive decomposition from this sewage sludge deposited in time past and accumulating year by year, make heavy demands on the oxidizing capacity of the harbor waters and leave each year a diminishing residual capacity to handle satisfactorily new incoming sewage.

Q. If this progressive pollution which you have just described of the harbor waters continues, what result will evolve, in your opinion?

A. If the present overload on the capacity of the harbor waters to partially purify sewage by oxydation, continues, there must inevitably occur at an early date, a sudden collapse or break-down of this purifying capacity. This natural, partial purification of sewage by dilution in harbor waters is a chemical action, brought about by biological or bacterial agencies. Within certain limits, these bacterial agencies will respond to an increased demand on them and will increase their purifying capacity, mainly by multiplication of units, up to a moderate overload, but when their maximum capacity has been reached and passed, these agencies become seriously impaired in their purifying capacity by the excessive overload thrown on them, with the result that they are not only no longer able to carry the overload, but rapidly decline in their capacity to fully carry even their normal load.

In many parts of New York Harbor and adjacent waters, at present these bacterial agencies are already under an overload, and

at some densely polluted points they have already broken down
987 and collapsed in their capacity to carry the overload. This is characteristically true of Gowanus Bay, Newton Creek, Passaic River and must very soon occur in the Harlem River. A continuation of the present progressive increase in the rate of pollution will, in my opinion, very soon bring many other portions of our harbor into this same state of collapse, and the results of such a damaging situation would be of the most serious and disastrous consequences, not only in a sanitary way, but also in economic and in commercial directions.

Q. Have you examined Defendants' Exhibits Nos. 8 and 9, prepared by Mr. G. C. Whipple, in which he gives the percentage of saturation of dissolved oxygen in New York Harbor waters, at sampling stations on November 3, 1909, and on May 3, 1919?

A. I have.

Q. How do you account for the fact that at many of these stations Mr. Whipple's results show higher percentages of saturation of dissolved oxygen in May, 1919, than in November, 1909, notwithstanding the fact testified to by Sanitary Engineers, that the waters of New York Harbor are progressively deteriorating in purity and that the content of dissolved oxygen is annually diminishing?

Mr. Riker: The question is objected to as being hypothetical in effect, and not based upon the statement of any facts, the reasonable explanation being that it is quite likely that the experts are
988 mistaken, as any other explanation.

The Commissioner: Note the objection of counsel for the defendants.

A. In order to explain Mr. Whipple's conclusion, and show its fallacy, it is necessary first to state what I presume is already in evidence in this case, possibly in numerous places, the fact that the oxygen content, to which Mr. Whipple is here referring, of the waters, undergoes a wide seasonal annual variation periodic in nature, being greatest when the opportunities for absorption of oxygen are the greatest, and when the demands on the stored oxygen are the least. This maximum oxygen capacity occurs therefore, at or near the end of the cool season, as in the spring, because in the fall, winter and spring months there is not only a better opportunity for aeration by the disturbing effect of wind and by the incoming large diluting supplies of water from the inland streams, but there is also an almost complete suspension of the demands on the oxygen by the sludge lying in the harbor already, that demand on the oxygen being a bacterial agency, and activity, is effected by temperatures, so that the activity of these bacterial agencies during the fall and winter and spring months are almost entirely suspended, and they make little or no demand on the oxygen in the waters. From
989 these two reasons, that is, the increased supply and reduced demand, the oxygen content shows a maximum at the end of the winter season or the spring season. In a corresponding way, the minimum of the year is produced. The warm temperatures of

summer greatly increases the activities of the bacteria, which are the agencies of decomposition, and which must have oxygen for their activity, so that the demand on the oxygen is greatly increased during the summer and early fall. These also are the periods when the least amount of diluting water and fresh incoming oxygen bearing water enter the harbor, and there follows, therefore, a well-defined minimum at the end of the season.

Now, Mr. Whipple, in making his comparison between 1909 and 1919, has, unintentionally, perhaps, chosen a date for his earlier date in November, 1909, a point very near the minimum of oxygen content for that year. He also has chosen his later date in 1919, in May, near, if not at the point of maximum oxygen content of the harbor waters; so that, even though the harbor waters are declining year by year, both in their maximum oxygen content at favorable times of the year, and their minimum content, this comparison of Mr. Whipple's, starting at the minimum and stopping at the maximum, would very naturally and expectedly show a decided increase in oxygen content.

Q. Have you prepared a diagram which will illustrate that
990 fallacy?

A. I have. (Indicating.)

Q. Who prepared this diagram?

A. I did.

Q. Personally?

A. I did.

Dr. O'Sullivan: I offer this diagram produced by this witness, and ask that it be marked Complainants' Exhibit 255.

By Mr. Riker:

Q. What facts is this diagram based on, which is in evidence?

A. It is based on the facts which I have just described, that the oxygen content of waters throughout the year undergoes a well-defined periodic variation from a maximum, at or near the end of the spring season, to a minimum at or near the end of the fall season.

Q. What determinations of oxygen are there in evidence which demonstrate that to be a fact, if any?

A. I can not from memory refer to these, but if you wish, I will seek them out, and try to give you some references to those.

Q. I did not ask that. I am examining you on this ingenious diagram of yours, and I am asking you what oxygen determinations it is based upon, if any, that are in evidence?

A. A portion of this exhibit is based on Mr. Whipple's own determinations of oxygen, that is the portion which relates to the slope line, running from *c* to *d*. The remainder of the exhibit is what I refer to, and which I supposed you meant when I referred to the data on exhibits in evidence showing that there is a periodic varia-
991 tion throughout the year.

Q. Now, on what oxygen determinations do you base your statement that the oxygen dissolved, is observed at the time of annual

minimum, in November. Have you got any proofs on that, except your own opinion?

A. I believe there are proofs—I am sure there are proofs.

Q. Point out where they are.

A. I can not at present refer to the particular exhibits.

Q. Do you refer to them?

A. I do.

Q. When you mean this?

A. I refer not only to them, but primarily and mainly to my own knowledge of what takes place in the harbor waters, as frequently testified to and admitted by all sanitary engineers, and by chemists of the harbor waters.

Q. I ask you again, what dissolved oxygen determinations you referred to which are in evidence for the preparation of this diagram, with particular reference to the observed oxygen determinations, observed at the time of annual minimum?

A. I can not reply from memory, I can not tell you which exhibit they are in, but I will ascertain if possible just which ones show that.

Q. You can not say now?

A. I can not say now the number of those exhibits, no, sir.

902 Q. Now, will you tell the oxygen determinations referred to by you, upon which you based your notation here on this diagram of the oxygen dissolved and observed near the time of actual maximum; where did you fix that from?

A. I took that from Mr. Whipple's testimony which is in evidence as Exhibits Nos. 8 and 9.

Q. Does that determine that November or May is the time of the annual maximum of dissolved oxygen in the waters?

A. No.

Q. That is what I am asking you for.

A. No, you asked on what I based my value of the oxygen content——

Q. We won't discuss what I asked you. That is not an answer. What I want to know is where you got your annual maximum fixed on this diagram—from what exhibits and what oxygen determinations you got that, as the maximum annual dissolved oxygen.

A. You will note that I have not given any numerical values to the maximum, nor to the minimum. This diagram is not drawn to scale, and it does not give anywhere on it the numerical values of the maximum——

Q. I asked you the numerical values.

A. But the fact that maximum exists is the fairest.

Q. On what is it based?

A. It is based on my own knowledge of the chemical results of the examinations by numerous chemists, and which I believe are in evidence in this case heretofore.

903 Q. Have you seen them?

A. It is a well-established fact.

Q. Have you seen them?

A. It is so well known in my mind that I can not say whether I have seen this particular data or not.

Q. Then, both as to the time of annual minimum of dissolved oxygen and the time of the annual dissolved oxygen in the waters of New York Bay or New York Harbor, you have nothing in this case that you can point to to justify this diagram?

A. I will repeat again, for the third time, that in my opinion there is in this case data which shows that very clearly.

Q. Well, point it out.

A. But I can not point it out without having a chance to examine those exhibits. I can not tell you the exact exhibit which gives it. It may even be the case that they come from more than one exhibit, but nevertheless, I repeat and reiterate the fact that it is an established and well-known recognized fact among sanitary engineers and water chemists particularly of stream waters and harbor waters, that the oxygen content of the waters undergoes a periodic change during the year, containing a maximum at or near the end of the cool season, and containing a minimum at the end of the heated season. That is an established fact.

Q. When did you prepare this diagram?

A. I prepared it within the last two or three days.

994 Q. I see it is dated August 12th, 1919. Is that the date of its final preparation?

A. That is the date when I submitted it.

Q. That is the date when you submitted it?

A. Yes.

Q. Not when you finally prepared it and finished your preparation?

A. I finally prepared it not earlier than the 8th and a portion of it was added on the 10th of August.

Q. Now, you have on the top line here an inscription: "True gradual rate of decrease in annual maximum of dissolved oxygen." Where did you get the figures which you reached that conclusion from?

A. The observations of chemists and bacteriologists as to the gradual declining content of New York harbors, at various points, year by year, much of which is in evidence in this case.

Q. When did you examine those figures?

A. Some of them I examined this morning, some yesterday, some the day before.

Q. What did you examine this morning?

A. I examined the evidence submitted in one of the exhibits offered by Mr. Kenneth Allen. I examined also——

Q. What exhibit was that, the number please?

A. I have not my exhibits here.

Q. Do you mean to say that any exhibits that have been produced in evidence here, show the determinations for any month of May?

A. I am not sure whether they do or not.

Q. Do you mean to say that any of the exhibits show oxy-

995 gen determinations of samples taken in any year, in the month of November, except Mr. Whipple's?

A. Yes, I think they do.

Q. What months?

A. Those made by the engineers of the Metropolitan Sewerage Commission.

Q. Can you refer to them?

A. I can not by number now, but I will tell you later, if you desire.

Q. Did you refer to them when you prepared this diagram?

A. I did, before I reached the conclusion on which this diagram was prepared.

Q. Well, this diagram was prepared in the last two or three days, and you can not state now what those exhibits were?

A. The diagram was prepared itself on the paper in the last two or three days, but my knowledge on which that diagram is prepared is of much longer life than that.

Q. When?

A. It is based on knowledge which I have been familiar with for the last ten or twenty years.

Q. When did you examine the exhibits of determinations to which you refer, and say they were prepared by Mr. Allen, for the month of November, in some years?

A. I examined those casually this morning, and also the other day.

Q. What other day?

A. I think on the seventh.

Q. When were these samples taken by Mr. Kenneth Allen, what year?

A. Some of the samples were taken in 1917, some in 1915, some in 1916, some in 1914.

996 Q. Yes. Those are——

A. And the observations made by the Metropolitan Sewerage Commission also run through several years extending back from 1908.

Q. When did you examine those later observations, this morning?

A. Not this morning.

Q. Two or three days ago?

A. Within the past week I have examined them, but not for the purpose of preparing this diagram.

Q. Now, as a matter of fact, don't you know, Prof. Landreth, that none of the exhibits that you refer to as having been made by Mr. Kenneth Allen, embraced any determinations of oxygen from samples taken either in the month of May or the month of November in any of the years that you have named; don't you know that?

A. That may be the case, and that does not interfere or discredit my answer which related to the gradual decline of the maximum, as indicated by the sloped line you refer to.

Q. I did not ask you whether your testimony was discredited at all. I asked you for a fact, Prof. Landreth, and you say that as a matter of fact you are unable to say whether those exhibits show samples taken either in the month of May or the month of November, in any year; is not that the fact?

A. I do not know whether they did or not. I do not care much whether they did or not.

997 Q. I did not ask you whether you cared. I asked you whether you know they did.

A. I do not know, distinctly and definitely, whether they did or not.

Q. And still you have examined them within the last two or three days?

A. Yes.

Q. And you do not know when they were taken?

A. I do not know whether they were taken at the times you specify.

Q. Well, do you know whether they were taken?

A. I do not carry in mind the dates, because I have the exhibits themselves in another room for examination, whenever I need them.

Q. What is the definition of a fallacy?

A. A wrong conclusion based on facts which should lead to another conclusion.

Q. And that is your definition of a logical fallacy, is it?

A. It is just an offhand definition. I have not consulted the dictionary.

Q. In taking the determinations made by Prof. Whipple in 1909, and those made in 1919, do you mean to say that there is any fallacy in the conclusions that he reached?

A. There is a fallacy in the conclusion that the harbor waters have increased, progressive and generally, from 1909 to 1919.

Q. Do you mean to say that he testified they had?

A. He did not testify to the fact that he had made a

998 fallacy, of course.

Q. I asked you whether he testified, so far as you know, that the condition and character of the water had improved from 1909 to 1919?

A. When he was asked as to the change in quality, he submitted this answer, this exhibit of his in the form of his answer which does show, on the face of it, and without properly analyzing it, a progressive improvement, and I accept that as his intended expression of opinion.

Q. Yes. You say there is a fallacy in the conclusion, which are these two sets of observations, do you. Will you point out what the fallacy is?

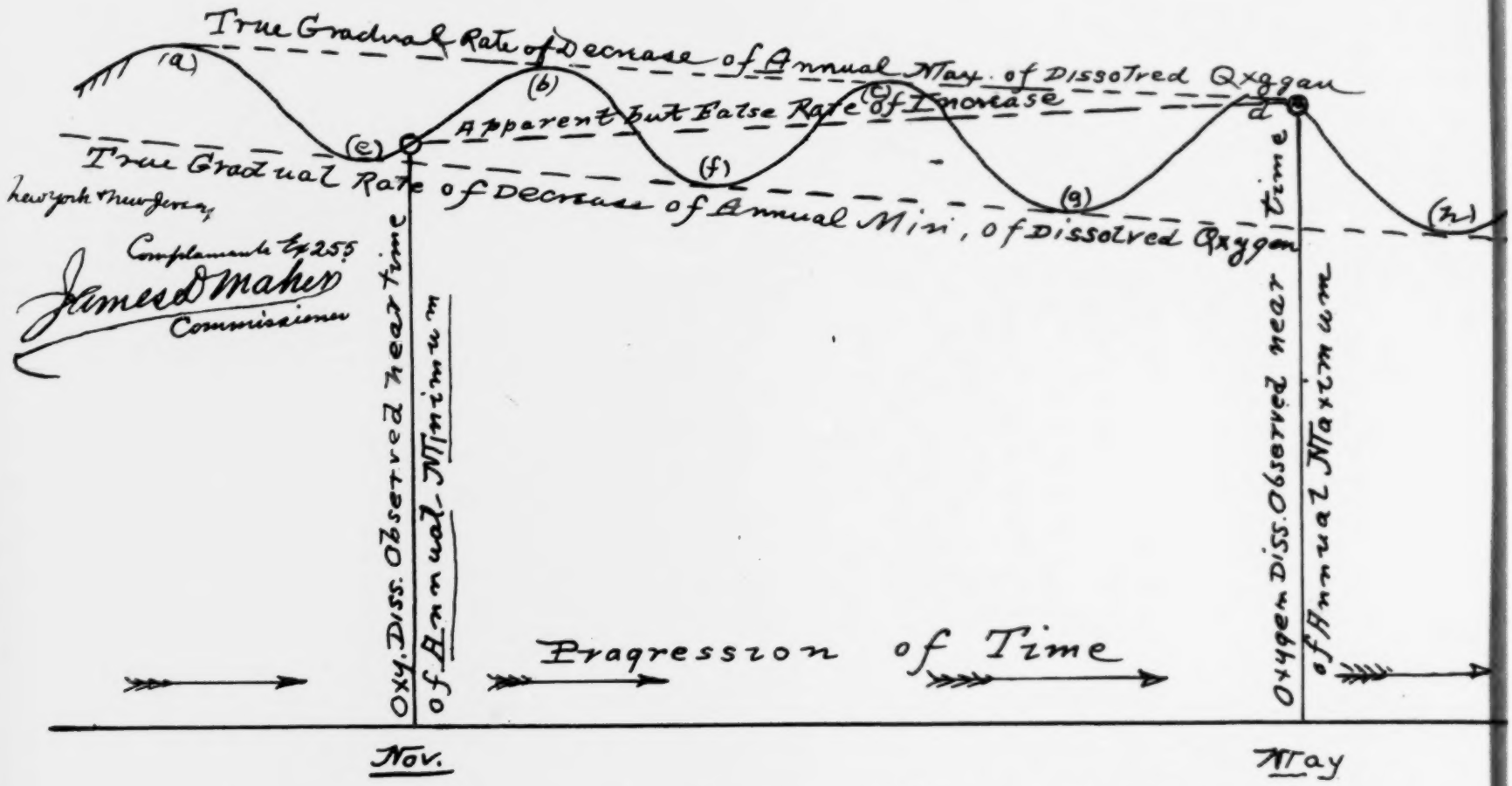
A. The fallacy lies in the wrong conclusion that because Prof. Whipple's value of the oxygen content in 1919 is larger than his oxygen content in 1909, that thereby there has undergone an improvement in the harbor.

Q. Did he say so?

A. Not in so many words, but he offered this table of data as his answer to that line of inquiry, and left it to be concluded, and argued on, that there was a progressive improvement in the harbor.

Q. Now, I ask you to point out the fallacy of that conclusion from the observations that he has produced; do you doubt the truth or correctness of his observation?

A. I do not.



New York & New Jersey
Complaments Ex 255
James D Maher
Commissioner

Dissolved Oxygen in Harbor Water Fallacy of Drawing Conclusions from Single Selected Dates.

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Q. And do you doubt that they were taken and made at
999 the times that they were testified to by him?

A. I do not. I accept his observations at their full value.

Q. Then, a proper statement of your fallacy would be that if anyone concluded from these two sets of observations, that the harbor waters had improved in character, that would be a fallacy?

A. That is so.

Q. Now, where is the fallacy in taking those as your premises of the conclusion, taking those as the premises—where is the fallacy in the conclusion?

A. The fallacy lies in the fact that there is nothing offered by Mr. Whipple to show that the normal value of oxygen content of the waters is any greater in May than in November, and the absence of that—one concludes from his evidence without knowing of that fact of that annual periodic fluctuation, that there has been a decided progressive improvement in the quality of the waters.

Q. Did he offer anything that you know of, in this testimony, except the mere fact of these observations?

A. Not that bears very greatly on this phase of the question.

Q. So that having set up a man of straw, you have produced a diagram here, based upon that assumption, have you not; there are not any facts in the case?

A. I have not set up any man of straw.

Mr. Riker: I object to the introduction of this paper as an exhibit, as containing nothing that is based upon any fact that has
1000 been testified to in this case.

The Commissioner: Note the objection of counsel for the defendants.

(The paper was marked Complainants' Exhibit No. 255.)

(Here follows drawing marked page 1000*a*.)

By Dr. O'Sullivan:

Q. Professor Landreth, can you state from memory how many thousands of oxygen determinations have been made by the New York Bay Pollution Commission, the Metropolitan Sewerage Commission, the Board of Estimate and Apportionment's Sanitary Engineers and Chemists, and by the Bureau of Sewer Plan, between the years 1903 and 1919?

A. I can not give you at all a close estimate, but it does run up into the thousands.

Q. Have you examined every exhibit on behalf of these complainants, from Exhibit 1 to Exhibit 254, and including this exhibit that is now marked Exhibit 255?

A. I have at one time or another. I have not re-examined them all in the past few days.

Q. Directing your attention to Complainants' Exhibits Nos. 8 and 9, and Defendants' Exhibit 8-A, I ask you if every determination made on May 3, 1919, by Mr. Whipples, does not show a higher oxygen value as to saturation than the tables which he submitted for November 3, 1909, with one single exception?

Mr. Riker: The question is objected to on the ground that
1001 the exhibits speak for themselves.

The Commissioner: Note objection of counsel for the defendants.

A. That is true. I have only been able to find one exception.

Q. Directing your attention now to Complainants' Exhibit 255, will you indicate what you already described in your testimony as the "fallacy" with regard to Mr. Whipple's three oxygen charts for 1909 and for 1919.

Mr. Riker: The question is objected to on the ground that the exhibit, when introduced, speaks for itself, and is not subject to explanation by the witness.

The Commissioner: Note the objection of counsel for the defendants.

A. I wish to point out the fact that the Exhibit No. 255 is marked "dissolved oxygen in harbor waters." "Fallacy of drawing conclusions from single selected dates;" and the fallacy to which one would naturally be led by an examination of Mr. Whipple's dissolved oxygen observations, without any further knowledge on the subject would be that there is a progressive improvement going on in the harbor waters; whereas, with such further knowledge of the phenomena of dissolved oxygen and its variations, and knowing from Mr. Whipple's exhibit that his earlier date was taken in November, which lies at or near the minimum point of the
1002 annual periodic variation curve, and that his later date in 1919 was taken at or near the date of the maximum point of such annual variation curve, it becomes evident that the improvement is not progressive, but is due to the position of the two points

chosen for comparison, and that had Prof. Whipple taken his observations in both years, either in November or in May, he would not have shown an improvement, but an impairment of the oxygen content.

Q. Directing your attention again to Complainant's Exhibit No. 255, I ask, Prof. Landreth, what do the letters on the curve on the upper part of the exhibit marked *a, e, b, f, c, g, d,* mean?

A. They mean to represent, not to scale, but in form of dimensions, approximately, the value of the oxygen content of waters, which is referred to the base line which is marked *h, j;* in other words, the vertical dimension from the base line *h, j,* to the curve *a, e, b, f, c,* etc., is intended to express the value of the oxygen content at the different times of the successive different years; so that since the measurement from the point *a* to the base line *h, j,* is greater than the distance *e,* to the base line. A decline during that season is represented by the portion of the curve *a, e,* similarly since the dimension from *b* to the base line *h-j* is greater than the dimension from *e* to *h-j,* it shows that in that portion of a year, there is an improvement in the oxygen content, and on through the sev-

1003 eral years; but a comparison of *b* with *a* and *c* and *d,* with one another, and identifying those by their numerical values, as given of successive years, and which are in evidence in this case, shows a progressive decline is taking place in the line *a, b, c, d,* namely, the maximum value of oxygen content year by year is declining; and similarly, the minimum content indicated by the line *e, f, g,* is declining.

Q. What does the dotted line in Complainants' Exhibit 255, extending from *e,* in brackets, to *d,* indicate?

Mr. Riker: The question is objected to on the ground that it does not appear in the case that the dotted line in question is founded upon any fact proved in this case, and that it is purely a hypothetical statement by this witness of his own opinions, not based upon evidence of fact produced here.

The Commissioner: Note the objection of counsel for the defendants.

A. The dotted line *e-d* simply indicates the apparent, but false rate of increase, of oxygen content, as deduced from the two single observations presented by Prof. Whipple, namely, one series in November, 1909, and one series in May, 1919. I do not wish to state that Prof. Whipple himself made the observations in November, 1909, but that he evidently had access to the records of observations made by others at that time, and he may himself have taken part in that determination.

1004 Mr. Riker: I move to strike this last statement out as not conforming to Prof. Whipple's own statement that he took the samples himself, and made his own observations in 1909, and as being an entirely gratuitous assumption by this witness.

The Commissioner: Note the motion of counsel for the defendants to strike out.

Q. According to Mr. Whipple's own testimony, Mr. Fair took those determinations in 1919.

Mr. Riker: 1909.

Dr. O'Sullivan: 1919.

Mr. Riker: Oh, 1919.

Dr. O'Sullivan: He did not even know the tidal conditions in 1909; they were very vague.

Q. Have you finished your answer to my question?

A. I should say further that this dotted line as here drawn is a straight line, because there are only two points there through which to draw it, one at *e*, and one at *d*, but it indicates by its ascending slope, the fact that a comparison of those two values would show an increase; but those two values are not typical of the year, the one being a minimum of the year, and the other being a maximum of the other years.

Q. And the inference you have already described as a
1005 fallacy, have you—the inference from these two exhibits, of an improvement?

A. Yes; the inference that there is a true increase of oxygen content, is a fallacy.

Mr. Riker: I move to strike out this last statement, that the inference of such a thing exists; if any such inference exists it exists only in the mind of this witness, and not by Prof. Whipple.

Dr. O'Sullivan: The motion is opposed for the reason that the two exhibits were put in evidence by Mr. Whipple for the purpose of showing, and which he himself in general terms stated, that the waters had not been deteriorating, while the figures actually showed on their face, an improvement of the harbor waters in their oxygen content.

The Commissioner: Note the motion of counsel for the defendants to strike out.

Q. You stated earlier in your testimony, Prof. Landreth, that the sludge deposits under the harbor waters make considerable drain upon the disolved oxygen content of the supernatent waters. I ask you why these sludge deposits do not move out with the tidal currents into the ocean?

A. They do not move with the tidal currents, because the tidal currents are not sufficiently strong to move some of them, and some of those which I refer to as not being moved, are those which have settled on the bottom, and become so firmly settled, that they
1006 are not distributed in position by the tidal currents. There are other portions of the sludge of the harbor, which settles near to the bottom, but remains partially suspended close to the bottom, but do move with the tides and with the currents. Now, that portion does not get out of the harbor, because of the barrier produced by the Sandy Hook bar, which offers on its inner slope, its up-stream slope, a strong grade or slope up which these semi-suspended semi-settled portions of the sludge which do swing somewhat with the

tidal movements which come out over that bar. They attempt to pass over, but are deposited on the up-stream slope of that bar, so that the depth of sludge at that bar, on the inner surface, is at least ten or twelve feet in depth, and represents the sludge, as it endeavored to flow out of the harbor, and meeting a barrier in the form of a ridge, which is produced by the variation of depth of 90 feet at least in the Narrows, to about 15 or 20 feet, and sometimes lower than that, on the bar.

This swinging sludge is not able to ascend up the inner slope of that bar, therefore it remains there. When the Ambrose Channel excavations were begun by the Government, the channel depth was cut partly through that deposit, and at the deepest portion of that deposit the depth of the sludge itself was at least ten feet, and in places twelve feet in depth, purely artificial in origin, carrying organic matter, oil, even organic solids, which had been rolled
1007 along the bottom.

Q. Did you yourself, design an apparatus or implement for penetrating into these deposits, and securing samples at different depths in the sludge deposits, to determine their character?

A. I did.

Q. And was that used by the New York Bay Pollution Commission?

A. No, it was not designed at that time—

Q. I mean the Metropolitan Sewerage Commission.

A. It was designed for, and used by the Metropolitan Sewerage Commission during the period in which Dr. Lewis was President of the Board. It was not used after Dr. Lewis left the Presidency of the Board, and after I retired from membership on the Board.

Q. During the dredging of the Ambrose Channel, did you yourself pay visits to the scene of the dredging, to examine the dredged material?

A. I did.

Q. And how did you find it?

Mr. Riker: This dredging is objected to as being immaterial and irrelevant in this inquiry under the order of March 10th, 1919.

The Commissioner: Note the objection of counsel for the defendants.

A. I found that the material dredged from the up-stream slope of the Sandy Hook Bar, which is the portion to which I have just referred, was signally foul and offensive, so offensive that the workmen on board the Government dredging boats were frequently
1008 nauseated, and not infrequently compelled to stop work, and recover, before they could resume. The dredging through the portions of the Bar that were beyond this deposit, were not attended by any unfavorable conditions. There was no odor. The material brought up was fairly clean sand, and that was true on the outer slope of the Bar, to a partial extent. There was some deposit on the outer slope, but only very shallow, as compared with the thickness of the deposit on the inner slope. I, myself, saw remnants

of tin cans brought up from a depth of at least six feet, and I think it was nearer eight or ten feet, at least six feet, in this deposit on the inner slope of the Bar. A tin can is peculiarly susceptible of movement, slow movement, along the bottom, because it is easier rolled, and unless it gets loaded with sediment inside, and anchored down, it is easily moved; and numerous instances were seen of tin cans, and of pieces of wood which had become water-logged, being brought up with the dredge. The entire material was black and offensive, and sickening in its odor, and even to sight.

Q. During the spring of each year, with the melting snows around the Hudson River basin and the freshets coming down, does it have any influence in increasing the sludge deposits in our harbor?

A. It does.

Q. How?

1009 A. By stirring up the deposits of sludge from the upper portions of the river, which had accumulated during the quieter portions of the river stage. The force of erosion is a function of the velocity, and increases as the velocity increases. The velocity increase is the greatest, during times of freshets, and hence the scouring action or the flushing action of the river on those upstream pools and deposits of sludge is the greatest during freshets, and they are brought down and move, as long as the velocity of the river is adequate to keep those deposits in action. As soon as they reach New York Harbor, however, where the velocity is checked and reduced by the large area of tidal way, the deposits are again allowed to deposit.

Q. Prof. Landreth, in your inspection of the Passaic Valley Sewage Disposal Works on July 30, 1919, did you observe any features in which the works, as now being built, are not in accordance with the stipulations entered into between the United States Government and the Passaic Valley Sewerage Commissioners of the State of New Jersey, under date of April 14, 1910, which stipulations appear as Complainants' Exhibit No. 135 in this suit?

Mr. Riker: The question is objected to on the ground that it is not within the scope of the order of March 10, 1919, and is therefore irrelevant and immaterial.

The Commissioner: Note objection of counsel for the de-

1010 fendants.

Dr. O'Sullivan: The inquiry is pressed for the reason that it is distinctly within the scope of the order, and it is calculated to show that this stipulation, instead of being improved, is depreciated and deteriorated by certain modifications in the plans agreed upon.

A. I did. I observed some deviations in features which were immaterial, or rather which features will be substantially equivalent to those which they displace. Other discordant features, if built, will not give as beneficial results as would have been given by the features which they displaced.

Q. Will you please mention and describe what you call those discordant features in the works as now being built which will, in your

opinion, give less beneficial results than those which they displace.

A. The stipulations between the United States and the Passaic Valley Sewerage Commissioners, under the heading First (*a*), require that the sewage on leaving the Trunk Sewer Tunnel shall pass through coarse screens to remove all large floating matter, then through one or more grit basins where the heavy matter may be taken out, from which basin or basins the sewage shall pass through self-cleansing mechanical screens having clear openings of not more than 4/10 of an inch in width.

In the works as now being built, the coarse screens stipulated are being provided, but so far as I could learn on inquiry, no
1011 grit basins are being provided, and no self-cleansing mechanical screens of any kind whatever are being provided.

Mr. Riker: The testimony now given is moved to be stricken out, on the ground that it purports to be nothing but hearsay.

The Commissioner: Note the motion of counsel for the defendants to strike out.

A. (Continuing:) This is a very distinct deviation and an exceedingly important omission from the features demanded in the stipulations. Those stipulations distinctly call for two entirely different screens having very different functions; the first or coarse screen to remove large floating matter, the second or self-cleansing mechanical fine screen to remove the finer suspended particles of sewage. The coarser screen is being supplied as stipulated; the finer screen is not being furnished at all.

Mr. Riker: Your Honor, that is a rash statement, very.

Q. Complete your answer.

A. (Continuing:) Mr. Fuller in his testimony (stenographic minutes, page 18), conveys the impression that the coarse screens being built are substantially equivalent to the fine screens stipulated, whereas the coarse screens being built simply meet the requirements of the coarse screens stipulated, and cannot at the same time perform
1012 the function demanded, of the additional finer self-cleansing mechanical screens which are stipulated but are not being furnished at all. Mr. Fuller apparently endeavors to make it appear that a coarse screen is equivalent in clarifying capacity to a coarse screen plus a finer self-cleansing mechanical screen.

It seems hardly necessary to refute Mr. Fuller's expressed opinion (stenographic minutes, page 18), that the screens now being built which have clear openings between the bars of ¾ of an inch will produce an equal amount of clarification as the self-cleansing mechanical screens having clear openings of not over 4/10 of an inch. The finer self-cleansing mechanical screens, which are being omitted, would be superior in clarifying or screening capacity to the coarser stationary bar screens now being built, in two respects: First, because a self-cleansing mechanical screen has the power to remove or screen out of sewage many more particles and smaller particles than a stationary, vertical bar screen having the same clear openings, and,

second, in addition to this the openings in the mechanical screens are smaller and the screening capacity or capacity for clarification is still further increased.

The 4/10 inch screen stipulated would have removed from the sewage, particles of solids having only 40/75 of the diameter of particles removed by the ¾ inch screen of the same type, and
1013 would have removed particles of solids, having only 0.15 or 1/7 of the volume or weight of those removed by the ¾ inch screen. As the small solid particles of sewage constitute many times the number and many times the aggregate weight of the large particles, the small screens, even if of the same type as the stationary bar screens, would have removed many times the weight of solids which the coarse screens now being constructed will remove from the sewage.

The ¾ inch screens now being built are not only coarser and allow particles of sewer solids to pass which are seven times as large in volume and weight as those which could pass the 4/10-inch screen called for in the stipulations, but they are of the old style stationary type. I should say the old style hand-cleaned stationary type which, for the same clear width of opening as the self-cleansing mechanical screen will remove only a small portion of the weight of solids which the self-cleansing mechanical screens would remove.

I wish to say in explanation of my term "stationary type," that I mean that while the screen is in operation, it is fixed and stationary. I do not mean it would not be removed, to have its particles cleaned out. That is the case. It may be taken out, but while it is taken out, another screen is in its place, so that the screening
1014 function is not interrupted. By the word "stationary," therefore, I refer to the condition of the screen, while it is functioning. In the self-cleansing mechanical screen, the screen is in motion all the time either by one device or another, and being in motion it acquires the capacity to remove a much larger proportion of the solids and much smaller particles, than is the case of a fixed screen against which the particles may float, and be ultimately pushed through, or washed through before they are removed.

Q. Prof. Landreth, you have just testified that the vertical bars or rods of the stationary screen being built as having clear openings of ¾ of an inch. How do you harmonize this with the statement made by Mr. Fuller on page 18 of the stenographic minutes in these hearings, in which he states: "They consist of iron bars placed so as to give a direct passage as one looks through the screens, a space of about ⅛ of an inch?"

A. The bars, according to Mr. Fuller's testimony, are placed at actual distances apart of about ¾ of an inch, but being placed in a staggered or zig-zag fashion, they give a direct visible opening as one looks through the screens parallel to the axis of the sewer of about ⅛ of an inch. The width of this visible opening, namely ⅛ of an inch, has nothing whatever to do with the fineness of screening. The important dimension is the actual distance between
1015 the bars of the screen, which Mr. Fuller states is about ¾ of an inch.

I have a little sketch here which explains what Mr. Fuller states, and evidently means, and which removes any apparent conflict of statement.

Q. Have you got that sketch with you, Professor?

A. Yes. (Handing paper.)

Q. What data did you prepare this sketch from, Prof. Landreth?

A. From the data furnished by Mr. Fuller in his testimony, namely, on page 18 of the stenographic minutes.

Q. And with what object in view have you prepared this sketch?

A. In order to harmonize and explain the apparent conflict which one might consider existed between Mr. Fuller's dimension of ⅛ of an inch, and his dimension of ¾ of an inch.

Dr. O'Sullivan: I offer this sketch in evidence and ask that it be marked Complainants' Exhibit No. 256.

By Mr. Riker:

Q. Did you see any screen?

A. I saw the place where the screens were in, the screens were not themselves in place.

Q. What do you mean then by saying that you are dealing with screens that are being constructed?

A. I am depending on Mr. Fuller's testimony?

Q. You do not know whether Mr. Fuller's testimony is true or not?

A. I have no means of knowing as to that point.

Q. This, then, is your graphic illustration of what you understand to be Mr. Fuller's testimony in regard to these screens?

A. It is.

Q. It has no reference whatever to anything that you saw?

A. Except that what I saw concurs, as far as I was able to see anything, with Mr. Fuller's statement.

Q. In what respect did anything that you saw of the matter of the screens themselves have anything to do with Mr. Fuller's testimony?

A. Mr. Fuller testifies that those are to be caged screens, as he calls them.

Q. Calls them what?

A. Cage screens, meaning that they are to be removed occasionally for hand-cleaning, when they have become filled with rubbish. I saw in the construction, actually going on, the place where that movable screen can be placed, and I assume is to be placed.

Q. You did not see the screens, I think you said?

A. I did not see the screens.

Q. You can not say from one thing you have observed, how many screens were being installed?

A. I only saw that there were places for two screens; one to be in operation when the other was being cleaned; and I assume that those places were intended to receive two screens, as Mr. Fuller testified.

Q. Were you able to determine that there were no other
1017 screens than the coarse screen which you have endeavored to illustrate from Mr. Fuller's testimony was in fact to be placed in the portion of the sewage flow?

A. I made inquiry as to the existence of such other screens, and was told that no other screens were being provided. Mr. Fuller's own testimony shows that no other screens are being provided.

Q. Were you able to determine from observation, whether or not another screen was to be placed in the works, other than the screen you described?

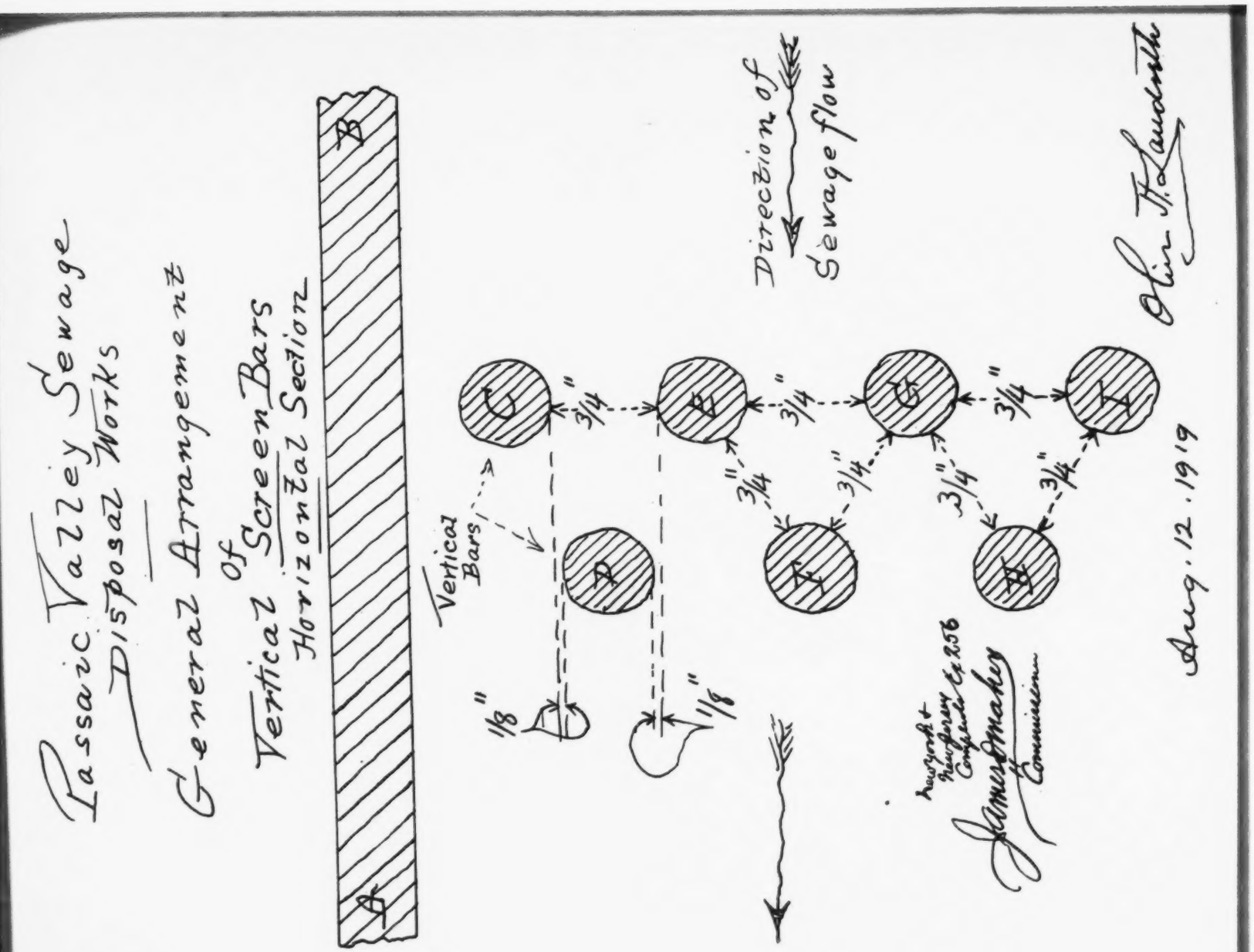
A. I did not see a place where any could be placed, and I traced the flow of sewage at all points which were accessible to me on that day from the point of entrance from the tunnel, to the point of leaving the detention basins, and I did not discover any place where other screens could be placed.

Mr. Riker: The offer is objected to as being merely an interpretation by a graphic illustration of the testimony of some other witness, and not being based upon any facts within the knowledge of this witness.

The Commissioner: Note the objection of counsel for the defendants.

(The paper was received and marked "Complainants' Exhibit No. 256.")

(Here follows drawing marked page 1017*a*.)



By Dr. O'Sullivan:

Q. Prof. Landreth, directing your attention to Complain-
1018 ants' Exhibit No. 256, will you explain what the diagram means through the various letters that are on top of the diagram.

A. The diagram is intended to represent a horizontal section through the screen and through one side of the chamber along which sewage flows, the direction of sewage flow is from right to left on the diagram, as indicated by the direction of the arrows, one of which is marked "Direction of Sewage Flow." The solid construction or wall on the upper portion of the diagram marked A-B, is intended to represent one side of the sewer channel or screen chamber through which the sewage flows. Circles which are placed across the diagram and are marked C, D, E, F, G, H, I, represent the first seven of the screen bars, or vertical bars, which are intended to be used. I do not wish to state distinctly that these bars are to be round. There is nothing in the testimony, and I have no knowledge as to whether they will be round bars, though I assume they will be, or square bars, or flat bars. That matter of form is of immaterial consequence, however, since the material element of the factor, is the clear distance between the adjacent bars; and Mr. Fuller states that to be ¾ of an inch. He also states that these are placed in a zigzag or staggered situation, and I have indicated them as being in such a direction. In order to answer the question sub-
mitted to be as to an implied conflict between the dimension
1019 ⅛ of an inch and ¾ of an inch, I have shown the dimensions to which Mr. Fuller evidently refers when he speaks of the clear direct opening looking along the sewer, as the sewer flows, of ⅛ of an inch. By that he evidently refers to the visible opening which one can see looking in the direction of the axis, between the bars, for example, C, and the bar, D, there would be a narrow clear space there of ⅛ of an inch. Notwithstanding the fact that the bar C is removed from the bar D by the matter of ¾ of an inch, and that that is the opening through which the sewage would pass, so that sewage would pass through the opening, first between C and E, and then through the opening between C and D, or between D and E, and would pass out.

So I have stated that the width of ⅛ has nothing whatever to do with the screening capacity of the screens. It is the dimension ¾ of an inch which is determinate and important.

Q. Prof. Landreth, by the time that the Passaic Valley sewage reaches the disposal works and will come to these screens, as described by Mr. Fuller, in what condition would you expect to find it, from its long transit, its many pumpings, and siphonings, as testified to in this case?

A. I should expect, physically, its solids would be very largely broken up into smaller particles; that biologically the putrefactive agencies would have somewhat progressed, having had sev-
1020 eral hours in which to operate, and that the product of such bacterial agencies, namely, the chemical elements in the sew-

age, would have undergone progressive change, so that the sewage would be what might almost be called stale sewage, and be several hours old; but principally, so far as relates to the screening element, the sewage particles would be well broken up by the long flow and by the operations that the sewage passes through, from the time it is deposited in the sewers, until it reaches the screens.

Q. And what effect would screens with ¾ inch openings have upon sewage of the type that you have just described?

A. They would screen out any dead cats or undershirts that came down, doubtless.

Mr. Riker: What about babies—take them out?

The Witness: That depends on the age. As to the removal of any appreciable portion of the actual sewage solids, it would have almost no effect.

The Commissioner: We will take a recess for an hour.

After Recess.

Q. Professor, have you read the testimony of Mr. George W. Fuller, given at these hearings on June 4th and 5th, 1919, as set forth in the stenographic minutes of these hearings?

A. I have.

1021 Q. Have you particularly read that part of Mr. Fuller's testimony, beginning on page 24, which covers his several recommendations or proposed added arrangements by which he expects to lessen the polluting effect of the effluent, from the proposed Passaic Valley Trunk Sewer, upon the waters of New York Harbor?

A. Yes, I have.

Q. Will you very briefly enumerate the several different arrangements which Mr. Fuller proposes to employ in order to lessen the pollution which has been alleged will result from the use of the Passaic Valley Sewage Disposal Works, and Trunk Sewer, as they are now being constructed?

A. He proposes:

First: Reduction of velocities through the sedimentation basins.

Second: Finer screens between the sedimentation basins and the outfall tunnel, in order to intercept in hot weather the gas-lifted sludge.

Third: The aeration of sewage in the trunk sewer tunnel above the pumping station.

Fourth: Variation in rate of pumping the sewage out to sea, or out to New York Harbor.

Fifth: The use of chemical precipitants before the sewage enters the sedimentation basins.

Sixth: Flushing the flat-graded sewers tributary to the trunk sewer by a hose from hydrants.

1022 Seventh: Flushing these same sewers by flushing gates, as he calls them.

Eighth: Directing small brooks into these tributary flat-graded sewers to prevent the stranding of sewage solids.

Q. Will you briefly describe the first proposed additional arrangement of Mr. Fuller's, namely, the proposed reduction of velocity of sewage flow through the sedimentation basins, and give your opinion as to its feasibility and efficacy. You will find a description included in my question on pages 25 and 75 of the stenographic minutes of Mr. Fuller's testimony, taken at these hearings.

A. Mr. Fuller proposes, on page 25, and again refers to it on page 75, to maintain the same period of detention in the sedimentation basins, and to reduce the distance passed through by the sewage, to one-third its original planned distance, thus to obtain a velocity of one-third of the original resulting velocity. If that arrangement can be produced, it will be beneficial, but Mr. Fuller proposes to introduce it into the present sedimentation basins, with moderate alterations, by dividing up the whole distance of sewage travel across nine hoppers, making a total distance of, as he says, 216 feet; dividing that into three portions, so that one-third of the sewage should pass over the first third of that distance; another third of the sewage should pass over the second third; that is to say, should enter
1023 the basin at the end of the first third, and leave it at the end of the second third; and the remaining one-third of the sewage should enter at the second third, and leave it at the end of the third third; and I repeat that in my opinion if that could be done in the present basins, it would accomplish some probable improvements in the results of sedimentation, but Mr. Fuller proposes to do so without rebuilding the exterior walls of the sedimentation basins, and apparently without any great or material alteration of the construction of the basins. I judge that from his statement, and also from his estimate on cost. He considers that he would be able to introduce sewage at these two new points, namely, at the end of the first one-third of the length, and again at another place, at the end of the second one-third of the length, and also take out the portions which end there, namely, take out the sewage which ends at the end of the first one-third, and put in a new portion of sewage, which shall flow on through the second one-third; and there, again, to take out that portion of the sewage and introduce the new remaining one-third at that point, and let that flow through the latter portion.

Now, those nine spaces into which the total length of flow is divided, forming nine hoppers, are each 24 or 25 feet in width, and come right together. There is no margin or distance between
1024 them. One joins the other. There is, therefore, no room for the very spacious necessary inlet and outlet connections for those portions of sewage in that space, without doing either one or two things: Either without encroaching on the total distance, and thus cutting down the total line of travel to less than one-third in each case, or else to introduce the sewage at considerable velocity in small pipes, and thus to introduce the very harmful element of agi-

tation and high velocity on entering the one-third portions. He does not contemplate, I take it, any reconstruction of the hoppers, nor of the elaborate and extensive connections which lead to and from those hoppers, those which lead the sludge from those hoppers into the sludge main, but simply to install troughs, or inlet pipes at those points. It is quite possible that he might do that under the limited expense which he refers to, but if he does, he will both cut down the distance traveled through, somewhat, and he will introduce what is more harmful by his high pressure pipes and high velocity. He will introduce an agitation into the volume of sewage, which should be quiet, and should be clear from eddies, and thus prevent the very thing he is seeking to accomplish, namely, a sedimentation arrived at through quiet or slow motion of the sewage.

Q. In your opinion, could the changes proposed by Mr. Fuller to reduce the linear velocity of the sewage flow through the sedimentation basins by changing the influent and effluent connections,
1025 be carried out within the cost stated by Mr. Fuller?

A. In my opinion they could not, except by resorting to the device which I have just described, of hanging or supporting pipes of small size, and therefore pipes in which the velocity would be very great for the inflow and outflow parts, and it should be pointed out that an outflow pipe demanding a high velocity through it, will react and impart this high velocity to the sewage flowing to it from the basin. The sewage must be received at concentrated openings, at comparatively small openings. The sewage must be diverted to these openings by acquiring a high velocity, and that high velocity may not be imparted instantaneously. It must be arrived at gradually by the sewage in the latter portion of the one-third tank, gradually increasing its speed, above that which is assumed to exist, namely, about half an inch of linear flow per second, it must increase it many times that, and thus to shorten the effective length of the one-third portions of the total basin length by very material deductions at each end, the influent end and the effluent ends. Under a reconstruction that high velocity could be avoided, but it would mean the entire dismantlement of the interior arrangement of the business, the rebuilding of the hoppers and the connections leading to them, and that could not be done anywhere within the limit of Mr. Fuller's estimated cost.

1026 Q. What result, as expressed in an increased degree of purification of the effluent from the sedimentation basins, does Mr. Fuller state will follow as a consequence of the reduction of linear velocity of sewage flow as proposed by him?

Mr. Riker: The question is objected to as the record is the best evidence of what Mr. Fuller stated.

The Commissioner: Note the objection of counsel for the defendants.

A. Before such reduction of velocity he estimates the removal of total suspended matter in the sewage would be between 50 per cent and 60 per cent of the original total suspended matter, and the removal of total organic matter would be between 25 per cent and 30

per cent of the total. After the introduction of his proposed changes bringing about a reduction of velocity of sewage flow through the sedimentation basins, he concludes there would be no doubt of *that* the removal of 60 per cent instead of 50 to 60 per cent of the total suspended matter, and no doubt about the removal of about 30 per cent of the total organic matter, instead of from 25 to 30 per cent.

Q. Where do these estimates of Mr. Fuller's appear, at what pages in the stenographic minutes?

A. On pages 23 and 25.

Q. Does a comparison of Mr. Fuller's two estimates, one
1027 before the other after his proposed reduction of linear velocity of flow, indicate an expectation on his part of any great improvement in the quality of the effluent from the sedimentation basins, due to his proposed manner of reducing the linear velocity?

Mr. Riker: The question is objected to on the ground that it is not a matter of expert opinion. If anyone is capable of judging, it is not this witness.

The Commissioner: Note the objection of counsel for the defendants.

A. No. Evidently only a feeling of greater certainty on his part that the degree of purification of the effluent from the sedimentation basins will amount to a removal of total suspended matter of 60 per cent, and a removal of total organic matter of 30 per cent of the original.

He clearly admits thereby that the sewage will leave the basins and be discharged into New York Bay at Robbins' Reef with 40 per cent of the total solid matter and 70 per cent of the total organic matter of the original sewage.

Q. Prof. Landreth, will you briefly explain Mr. Fuller's second proposed addition to the disposal plant, namely, the installation of very fine screens between the sedimentation tanks and the effluent tunnel, as described by him in the stenographic minutes at page 27?

Mr. Riker: The question is objected to on the ground that
1028 the record speaks for itself, and the effect of this testimony is a matter for the determination of the Court, and not by this witness.

The Commissioner: Note the objection of counsel for the defendants.

A. Mr. Fuller proposed on page 27 of the minutes, to install, if it should be found necessary, very fine screens placed in the effluent water connections or sewage connections through which the sewage would pass from the tanks to the tunnel leading to New York Bay. He is referring there to the removal of sludge, not the ordinary solids, but the sludge which has already once settled to the bottom; and in hot weather has become putrefied, and has formed sufficient gas to buoy it and lift it up, and float it toward the surface where it would not only accumulate in a greatly increased depth of sewage scum, but also where it would give off the noxious odors, and while rising it would be carried out and carried forward into New York

Bay. Mr. Fuller proposes to intercept that gas-lifted sludge, not the original settling solids at the fresh stage of the sewage, which has just come in the tank, but that which has been there perhaps for hours or days, at the bottom, and is fermented, and putrefied, and has arisen, and he proposes to intercept that by fine screens.

1029 These fine screens would not intercept this gas liquid sludge, unless they were exceedingly fine, because that material is exceedingly fine; and while it comes up sometimes in large flakes or cakes, it is so easily broken up that a hose of water or the spraying of water will separate it and break it up into its constituent granules or portions. Consequently, a screen to intercept that must be fine enough not to intercept the whole cake or flake, or haul back, but to intercept the individual units of which that is made. Now, if it is fine enough to do that, it would also intercept a large portion of the solids which are going down for the first time, and would take out of the sewage therefore, some, and perhaps a larger part, while it is in operation, of the highly objectionable material; but that would require mechanical ways for operating those screens, and handling a large amount of material accumulating on those screens. Moreover, that is an emergency measure only for hot weather. He does not propose it continuously.

Q. Prof. Landreth, will you briefly explain Mr. Fuller's third proposed addition, that of aeration, as described in the stenographic minutes of Mr. Fuller's testimony at page 29 and state if, in your opinion, this would accomplish the results indicated by Mr. Fuller in his testimony?

Mr. Riker: Same objection.

The Commissioner: Note the objection of counsel for the defendants.

1030 A. Mr. Fuller proposes to aerate the sewage in the trunk sewer tunnel between Paterson and Newark Meadows, by blowing air into the sewage. He is careful to distinguish there between what he speaks of as oxydization and preservation. He says "I do not mean to imply that I am speaking of oxydization, but the delivery of air into the sewage to aid as a preservative, that is, to prevent putrefactive processes being established". The only preservative that air constitutes is by its oxydizing effect, unless it oxydizes it does not preserve, and that is particularly the case in the conditions present here, because the sewage will be in itself well advanced in decomposition. There will be a large amount of matter in solution, organic matter in solution. It will have lost all of its dissolved oxygen, doubtless long before it reaches the point of aeration, and it also is loaded with fine particles, fine solid matter.

Now, in the dosing of the liquid contents of that sewage by air, even if the absorption of oxygen were to take place as readily as Mr. Fuller apparently thinks, it would be attended by one harmful result, and another ineffectual result. In the first place, the first effect of blowing in air would be to create a large volume of noxious odors. We can not put air into a tunnel without taking some air

out of the tunnel. If you put it in under compression, it will
1031 come out under expansion. If not compressed below its natural atmospheric volume, when it comes out it will be loaded with these noxious odors, so that any point along the tunnel where he proposes to introduce this air, he must have some means of escape or ventilation for the air which escapes from the compressed air of the pipes through the bubbles of sewage, which will bring away a great burden of odors.

In the second place, he can not reach the real source of the odors which are in the great number of small particles, until he has first converted into a harmless condition or state, the liquid which forms their vehicle and which bears them along. That is only carried out by oxydization, and he can not preserve the solids against putrefactive odors, until he oxydizes the liquid medium in which those particles are being suspended and carried along.

Q. Professor, will you briefly explain Mr. Fuller's fourth proposed additional feature of a variation in the rate of pumping, as described in the stenographic minutes, at pages 30 and 98, and point out the consequence which would follow its attempted introduction?

Mr. Riker: The same objection.

The Commissioner: Note the objection of counsel for the defendants.

A. Mr. Fuller does not very seriously or very definitely say that he intends to do that. He introduces the thought of that
1032 into the testimony in the following language:

"If at certain intervals during the day the sewage was pumped at say one-half of the ordinary rate of speed, and at other intervals correspondingly at a greater increase above the normal, two things could be accomplished. In the first place, the use of a high rate of pumping could be availed of to promote higher velocities."

He therefore, I judge, is referring to higher velocities in the trunk sewer tunnel, which are desirable, but which higher velocities are the average of the high and the low velocity. He can not pump at a high rate without having pumped at a low rate at some time. During the period when he is pumping at a lower rate, that trunk sewer tunnel will become a sedimentation basin, and the solids will be thrown down, and they will be thrown down greatly in excess of the quantity which will be scoured out, when he increases his velocity again and gets above the normal, that is the invariable experience in sewers. Frequent tests have been made and experiments have been tried to endeavor to flush out sewers by damming up the sewers themselves, and letting the accumulated sewerage flush out the material below. It transfers the trouble from a point below the dam or place where the odor occurs to the point above it, because
1033 while that sewage is accumulating, it is also sedimentating, and is throwing down the solids. Those solids are not moved out when the velocity is increased, by moving the dam or increasing the rate of pumping, and the reason for that is that the increase in velocity is confined to the upper portion of the volume

of the cross-section of the sewer. In other words, the bottom part is increased very slightly, if at all. It is the top liquid that flows off and leaves the bottom liquid at only slightly increased velocity.

You can see that in any wash basin or in any stream, that velocity of different particles in given parts of the depth diminish from the surface down to the bottom. The highest at the surface, the lowest at the bottom. The bottom is where the sedimentary solids will go, while the dam is being formed, or while the velocity is being reduced; but you do not return to high velocity at that part when you increase the velocity by pumping, or when you remove the dam. Consequently, it is the experience and observation repeated in frequent cases, where efforts have been made to accomplish flushing in this way, that it accomplishes more harm than it does good, and it is inclined to transfer the trouble from below, where the flushing is sought to be, to above where the sedimentation takes place.

In the second place, the purpose Mr. Fuller has in mind is to regulate the discharge through the diffusion system of nozzles on
1034 Robbins' Reef, so that when the tide is near the turn, they are most sluggish, and the velocity is almost at zero. The little stream velocity existing there in the discharge of the sewage will also be reduced correspondingly. Now, that means that he must know and have some means of knowing what the velocity of the tidal run is, not at the surface where it can be observed, but forty or fifty feet deep, where it is quite different from what it is on the surface, oftentimes just the opposite; oftentimes with no velocity on the surface there is a strong velocity below, and vice versa, with strong velocity on the surface, when the tide is just turning below. The tide tables would therefore have to be tide tables of the running of tide, not on the surface, but down at the bottom. He would have to have a scheme or system of regulation by which he could intelligently transmit to the pumping station at all times the widely varying conditions of the tidal run at the nozzle points of different days. Now, if they were the same tomorrow they are today, and followed the same phase of the tide, it would be possible to formulate an arbitrary schedule, but it is not. It differs with the time of the moon. It differs with the wind, and numerous things; so that it would be impossible for him to time his pumping to conform to the periods of low tidal discharge over the nozzles. If he were to accomplish that, even
1035 if he were able to make such a schedule, it would convert his sedimentation basins, and the trunk sewer tunnel into what has been tried in the past and abandoned almost everywhere; namely, into partial tidal-detention basins—basins intended to store up sewage until the tide was favorable to take it out, and then let it go.

Q. Professor, will you state briefly Mr. Fuller's fifth proposed additional feature, that of chemical precipitation as described in his testimony in the stenographic minutes, on page 31.

Mr. Riker: The same objection.

The Commissioner: Note the objection of counsel for the defendants.

A. Mr. Fuller proposed that also as an emergency measure, and not as a regular measure. The removal of suspended solids by chemical precipitation is a well-known and established method. It is perhaps the oldest method of intelligent, scientific sewage disposal, certainly in the earlier plants, and at one prominent plant at least existing one today at Worcester, Massachusetts, which is operated on the chemical disposal system, but that is operated with carefully planned sedimentation basins, basins into which the sewage may pass, and means for mixing the sewage with the chemicals before they are allowed to settle. Mr. Fuller does not propose any-
1036 thing of that sort here. He proposed to introduce them just at the point where the sewage enters the basins.

There is one other point which should have attention, and that is the nature of the sewage itself. Frequently its chemical nature is an important factor in the efficacy of the chemical treatment of the sewage. If the sewage itself is already treated in chemicals, that treatment may aid or impair the effect of the artificially-added chemicals to use for precipitants. It may also lead to a production of artificial odors, which would not be produced under normal conditions.

Now, in this present case, Mr. Fuller states that one-tenth of the whole volume of sewage entering this trunk sewer, is to consist of trade wastes from the industries on the Passaic River. We do not know what those trade wastes contain, but undoubtedly they contain more or less chemical materials; and before such a plan as this is embarked on, a careful, chemical investigation of the sewage itself, particularly its chemical nature, should be made before a chemical precipitation solution is offered as remedy for existing evils.

I say again that it is proposed as a temporary measure, and not as a regular means of sedimentation. Mr. Fuller states by that that he will be able to increase the percentage of total solids removed from 60 per cent up to 85 per cent, and the total organic matter from 30
1037 per cent up to 50 per cent. I have no doubt but what both results can be obtained.

Q. Under what conditions could they be obtained?

A. Under conditions of opportunity for proper mixing, adequate detention and sedimentation after the addition of the chemicals.

Q. Is that provided for by Mr. Fuller in his suggested recommendations for improving the efficacy of the Passaic Valley Sewage Disposal Plan?

A. He does not propose to increase the volume of sedimentation basins on account of this precipitation at all.

Q. Prof. Landreth, will you state briefly Mr. Fuller's sixth, seventh and eighth proposed additional features of flushing the tributary sewers, by fire-hose taking water from hydrants, by so-called flushing-gates in the tributary sewers, and by diverting small streams into the sewers, as described by him in the stenographic minutes at page 33 of his testimony.

Mr. Riker: The same objection.

The Commissioner: Note the objection of counsel for the defendants.

A. Mr. Fuller had previously referred to the danger and trouble which is anticipated from the flat graded sewers tributary to the trunk sewer, and he speaks of the danger of the stranding of solids in these tributary sewers, and these three remedies, his sixth,
1038 seventh and eighth remedies are intended to meet or overcome the trouble from stranding in these branch sewers. His first means of doing it is by flushing the sewers themselves by hose from the nearest hydrant. That is the most effective way of flushing the sewer. It is not the most economical. It is very effective. It does the business, because it directs the jet of water where it needs to go, to the bottom of the sewer, and all around the sides of the sewer. If carried out in sewers large enough for a man to enter with a nozzle, or even if floated down the sewer, it is a fairly effective way to flush the sewer, but it is exceedingly expensive, and no city or town will resort to it, except under the most urgent necessity.

It, therefore, is one of these things that would not be classed as the regular means of operating a sewerage system. It is an emergency measure, and while it is effective, it is also expensive. It, however, I must repeat, is much more effective than either of his other plans.

His next plan, the seventh, is to overcome the stranding of solids in the tributary sewers having flat grades, by using what he calls a flushing gate. I have already referred to that in my characterization of one of his other methods, namely, he puts an obstacle tem-
porarily in the sewer at a manhole, a gate, which dams up the
1039 flow of sewage, so that it does not go past the manhole, but in turn accumulates by backing up into the sewers, and when a sufficient amount of sewage has been accumulated, he opens the gate and lets it flush down.

I have already spoken of that, and the effect of such an arrangement, that whatever effect it has, is one of improvement below the point of damming, but it creates another one equally great and usually greater on the portion of the sewer covered by the dam. In other words, he throws down more solids than he is able to move out by the same method. He must, therefore, carry his remedy successively upstream, manhole by manhole, and overcome the harmful effects which he has produced by the sedimentation in each case. That method has been repeatedly tried by sewer superintendents, and occasionally by engineers, who were not experienced in sewer behavior. I have seen it tried in at least a dozen places. It never has been employed more than two or three times in any one place. It is always abandoned as a hopeless and ineffective and expensive way of doing work which involves continual remedies. You are driving your disease from one point to another, and you must keep following it up with the same remedies.

His eighth and last means of flushing these same flat graded sewers
of removing the stranded solid from the sewage, is that of
1040 turning some convenient brook into the sewer. If the brook already exists, and is waiting to be turned in, I should, by all means, turn it in if the sewer was in need of the additional volume. It should be noted, however, that whatever is turned in must be

pumped out, and you have increased the volume of pumpage at the pumping station by whatever discharge the stream which you have turned in represents.

Q. Prof. Landreth, you have used the expression or terms, "flat grade." Will you please explain what is meant by those terms, as applied to sewers.

A. Grades so flat that under normal or under bad conditions, the solids, instead of being transported out with the contents of the sewers are stranded or are allowed to settle. By actual stranding is implied, as Mr. Fuller suggests, that the depth is so shallow that the solids are kept on the bottom and are stopped there. Whether they are stranded or whether they are sedimented out of the deeper depth of liquid, it is immaterial. The flat grade produces a low velocity, which increases sedimentation, and many of the sewers that are tributary to this trunk sewer tunnel are, as expressed by Mr. Fuller, of this character. That is further evidenced by the fact that he directs his attention to overcome that difficulty in several of these cases. The effect of that stranding is, of course, from a sanitary standpoint, highly objectionable, and permits the solids to be detained, and in time it permits the putrefactive
1041 condition to take place, and the development of obnoxious odors, and the washing down of the liquid content in putrid form into the sewage in the trunk sewer tunnel, and thus out through the basin into the Bay.

Q. Prof. Landreth, in your opinion, what would be the aggregate effectiveness of these several proposed additional features, suggested by Mr. Fuller in the testimony that you have alluded to, and given by him at these hearings, and which you have described, in materially diminishing the highly objectionable features with which the Passaic Valley Trunk Sewer Scheme is charged?

Mr. Riker: The question is objected to on the ground that it assumes that the Passaic Valley Sewage System is charged with highly objectionable features, that being the question for examination by the Court, and is not permitted or proved conclusively.

The Commissioner: Note the objection of counsel for the defendants.

A. With the exception of the first proposal of Mr. Fuller, that is, the reduction of linear velocity of flow of sewage through the detention basins or sedimentation tanks, which would be helpful if it could be accomplished, the several devices are trivial, emergency measures, and are clearly planned more to cure perfectly evident prospective defects in the Passaic Valley Disposal System,
1042 and to patch up its shortcomings, or at least to claim to patch them up, than to meet the purpose of the Court's order of March 10th, which was to discover "any practicable modification of the proposed system of sewage disposal, that may be added thereto or introduced therein, in order to lessen the alleged polluting effect of the effluent upon the waters of New York Harbor."

Mr. Riker: I move to strike out the last part of that testimony on the ground that it is an attempt by the witness to interpret the order of the Court.

The Commissioner: Note the motion of counsel for the defendants to strike out.

Dr. O'Sullivan: It is objected to and opposed as a motion, for the reason that the witness has quoted the language of the order of March 10, 1919, of the Supreme Court of the United States in this suit.

Q. Prof. Landreth, would the additions proposed by Mr. Fuller, if adopted, furnish any certainty of permanent improvement in the results to be expected from the proposed Passaic Valley Sewage Disposal System?

A. In my opinion, none, except from the proposed reduction of linear velocity of flow of sewage through basins, which, if properly designed and installed, both as to linear velocity and time of detention, would produce some improvement.

Q. Do you mean by that answer, that you favor Mr.
1043 Fuller's method and extent of securing a reduction of the linear velocity of sewage flow through the basins?

A. No. I do not. But a proper reduction of velocity and a proper detention period in the basins can be secured which would furnish some improvement, but not by Mr. Fuller's proposed changes of construction of the basins, which proposed changes, I judge from Mr. Fuller's meagre description and his estimate of cost, would be minor in character and not readily adaptable to the internal arrangement of the basins now being built, nor effective if introduced.

Q. Why do you consider that, aside from Mr. Fuller's first proposed addition, his other proposed additions would furnish no certainty of permanent improvement in the results to be expected from the proposed Passaic Valley Sewage Disposal System?

A. Because, first, those proposed additions are simply operative, and not structural or constructive. They are simply proposed ways of methods of operation which might be used or not, at the option or discretion of the operating staff, or even of subordinate and irresponsible members of that staff, and hence do not furnish any certainty of operation, much less any certainty of beneficial results. Second, those proposed additions are simply provisions for emergencies, or to meet the special conditions or deviations from the usual normal conditions which the principal system itself should fully provide for, but does not; whereas, what is de-
1044 manded, and what the order of the United States Supreme Court of March 10th, 1919, evidently contemplates, is substantial and permanent modifications of construction, arrangement or operation, which shall normally and continuously lessen the alleged polluting effect of the Passaic Valley Sewage upon the waters of New York Harbor.

Mr. Riker: I move to strike out the attempt of this witness to interpret and introduce into the Court Order features that are not

to be found there, and are merely his version of the meaning of that order. The Order speaks for itself.

The Commissioner: Note the motion of counsel for the defendants to strike out.

The Witness (continuing): I assume that the Court is seeking evidence, from the Defendants first, and then from the Complainant, regarding "practicable modifications" or improvements which shall be in some degree commensurate with the very serious, and very generally supported, allegations which have been placed before the Court as to the utter inadequacy of the proposed sewage disposal system to properly purify the Passaic Valley sewage before discharging it into the waters of New York Bay.

Mr. Riker: I move to strike out the assumption of this witness, as a hypothetical question based upon facts not proved in
1045 the case.

The Commissioner: Note the motion of counsel for the defendants.

A. (Continuing:) The defects alleged against the proposed system are serious, fundamental and permanent, not minor nor occasional, and call for remedies equally fundamental and permanent. Remedies of this character have thus far not been offered in evidence by the Defendants.

Mr. Riker: I move to strike out this last statement as the opinion by this witness as to the defective testimony.

The Commissioner: Note the motion of counsel to strike out.

Q. Prof. Landreth, do you know whether or not any of Mr. Fuller's recommendations as testified to by him at these present hearings, have been adopted by the Passaic Valley Sewerage Commission's Engineers?

Mr. Riker: The question is objected to as immaterial and irrelevant.

The Commissioner: Note the objection of counsel for the defendants.

A. I made repeated inquiry as to that point, and was told by the engineers of the Passaic Valley Sewerage Commission, including the Chief Engineer, that Mr. Fuller's proposed methods had not been submitted to the Engineer Department of the Commission, and were not under consideration by the Engineers.

1046 Mr. Riker: I move to strike it out as not an admission on the part of the Passaic Valley Sewerage Commissioners, and not within the terms of the permit which was accorded to this witness, to witness the work of the Passaic Valley Sewage Works, and therefore, for that purpose faulty.

The Commissioner: Note the motion of counsel to strike out.

Q. Professor Landreth, directing your attention to the Order of the Supreme Court of the United States, and particularly to the

paragraph marked (1), I ask if in your opinion the testimony given by the defendants' Engineer which you have read, adequately meets the requirements regarding practicable modifications of the proposed Passaic Valley Sewage Disposal System in order to lessen the alleged polluting effect of the effluent from this proposed system on the water of New York Harbor?

A. In my opinion, it does not.

Q. Have you yourself considered what practicable modifications of the proposed Passaic Valley System of Sewage Disposal, either as to construction, arrangement or operation, should be made in order to lessen the alleged polluting effect of the effluent or sewage discharged therefrom upon the waters of New York Harbor?

Mr. Riker: The question is objected to upon the ground that it is not within the purview of the order, and secondly, because the order does not say what should be made, but what can be
1047 made.

The Commissioner: Note the objection of counsel for the defendants.

A. I have.

Q. Have you reached any definite conclusions as to such practicable modifications that can be made?

A. I have.

Q. Have you formulated in definite terms, your conclusions as to such practicable modifications that can be made?

A. I have.

Q. Will you state and explain the recommendations which you have formulated regarding such practicable modifications of the proposed Passaic Valley Sewage disposal system as can be made.

A. I have formulated two quite distinct alternative sets of recommendations with the idea that one of these alternative sets of recommendations might be selected. These two sets of recommendations I have denominated as "Option A" and "Option B."

Both Option A and Option B are predicated on the retention and use of the proposed Trunk Sewer Tunnel, the proposed pumping station and accessory features on Newark Meadows, the proposed sedimentation basins and accessory features at or near the site of the pumping station together with such modifications of these three divisions of the disposal system as may be necessary to comply with the several requirements recommended under Option A or Option
B.

1048 In predicating my recommendations on the retention and use of the above divisions of the proposed Sewage Disposal system, I do not wish to be understood as favoring such retention and use, but I have assumed—perhaps without warrant—that the order of the Court of March 10, 1919, might, perhaps, not be construed as extending to the complete abandonment of the proposed Trunk Sewer Tunnel, pumping station, and sedimentation basins. If the order of the Court, in its demand for testimony regarding "any practicable modifications," be construed as extending to abandonment of the proposed pumping station and sedimentation basins on

Newark Meadows and the proposed Trunk Sewer Tunnel, or any portion thereof, my recommendations would be quite different.

Option A.

Of my two alternate sets of recommendations, the first, or Option A, contemplates the abandonment of all further construction and use of that portion of the outfall tunnel sewer which lines under the waters of New York Bay, and all portions of the discharging and dispersion systems under the waters of New York Bay, and the permanent abandonment of the proposed discharge of effluent or sewage from the proposed Passaic Valley System into any part of New York Bay.

Mr. Riker: I move to strike out the testimony of the witness as being clearly irrelevant and immaterial, as not being within the purview of the order, and not within the issues of the suit.
1049 In case the abandonment of this part of the work is accomplished, there is no jurisdiction of the United States Supreme Court over the subject matter.

The Commissioner: Note the objection of counsel for the defendants.

Mr. Riker: And the suggestion by this witness of a means of sewering the Passaic Valley, is impertinent, as he has not been retained or paid, nor asked to furnish testimony or suggestions or alternative plans, that deal entirely with the matters within the jurisdiction of the Supreme Court.

The Commissioner: Note the further objection of counsel for the defendants.

The Witness (continuing): It contemplates, however, the discharge of the effluent or sewage from the detention basins, as they may need to be modified, into any part of Newark Bay or into streams entering Newark Bay, as the Defendants may choose, at any point on, or up-stream from, the line where the effluent tunnel from the sedimentation basins to Robbins Reef crosses under the waters of Newark Bay. This discharge into Newark Bay is, of couse, to be subject to whatever regulations the Secretary of War may impose as a condition of such discharge, and should also be subject to a condition—imposed as an element of protection to the waters of New York Bay, or Kill van Kull and of Arthur Kill—that the
1050 effluent or sewage discharged from the proposed system into Newark Bay shall, before being discharged, be not less thoroughly and extensively purified than would have been necessary to meet, fully and unquestionably, the requirements of the existing stipulations made between United States and the Passaic Valley Sewerage Commissioners, dated April 14, 1910, and in evidence in the present case as Complainants' Exhibit No. 135, and as Defendants' Exhibits Nos. 6 and 7.

I have formulated the terms of this first set of recommendations in such forms as might be incorporated, either into stipulations

mutually entered into between the Complainants and the Defendants in this action, or into a decree to be issued by the Court. These terms, which should be incorporated either into stipulations or into a decree, are for Option A as follows:

First. That the Defendants, The State of New Jersey and the Passaic Valley Sewerage Commissioners, shall immediately upon the signing of these stipulations (or the issuing of this decree) completely and permanently terminate and discontinue all work leading to the construction, operation and use of that portion of the Passaic Valley Outfall Tunnel which lies under the waters of New York Bay, and of all portions of the outfall or dispersion works under the waters of New York Bay, including all branch tunnels, conduits, pipes and discharge nozzles.

1051 Second: That the defendants shall not at any time discharge any portion of the effluent or sewage from its proposed Passaic Valley System, either directly or indirectly, into any portion of the waters of New York Bay; except as provided in section Third herein.

Third. That the defendants, if they elect to complete and operate those portions of the proposed Passaic Valley Sewage Disposal System which do not lie under the waters of New York Bay, shall do so, if at all, only under the following provisions:

(*a*) The point of discharge of the effluent or sewage from such Sewage Disposal System shall be into Newark Bay or into a stream or streams flowing into Newark Bay, and at a point on, or up-stream from, the line where the Passaic Valley Outfall Tunnel passes under Newark Bay.

(*b*) The proposed discharge of effluent or sewage from such Sewage Disposal System into Newark Bay, or into a stream or streams flowing into Newark Bay, shall be subject to whatever conditions may be imposed by the Secretary of War as a condition of such discharge; except that in no case shall the effluent or sewage discharged from the Sewage Disposal System into Newark Bay be less thoroughly and extensively purified than would have been necessary to meet, fully and unquestionably, the requirements of an existing stipulation entered into between the United States
1052 and the Passaic Valley Sewage Commissioners, under date of April 14, 1910.

Option B.

Of my two alternate sets of recommendations, the second, or Option B, contemplates the permitted use of the Trunk Sewer Tunnel, the pumping station and accessory features on Newark Meadows, the sedimentation basins and accessory features adjoining the pumping station, the Outfall Tunnel Sewer under Newark Bay, Bayonne, and New York Bay, and the discharging and dispersion system under New York Bay, as these several portions of the system may need

to be modified, subject, however, to definite conditions imposing additional purification requirements on the disposal system situated on Newark Meadows, and requiring the abandonment of the discharge of effluent or sewage from the dispersion outlets or nozzles at any depth less than 45 feet below mean low tide at Robbins Reef, and prescribing that if the sludge or the screenings from the sewage disposal works be disposed of by dumping at sea, the dumping shall not take place within a prescribed minimum distance from the nearest point of land lying within the State of New York.

Mr. Riker: I move to strike out the testimony of this witness with reference to the point of discharge of sludge, as not being within the issues in this case, and being irrelevant and immaterial.

The Commissioner: Note the objection of counsel for the
1053 defendants.

The Witness (continuing): I have formulated the terms of this second set of recommendations in such form as may be incorporated, either into stipulations mutually entered into between the complainants and the defendants in this action or into a decree to be issued by the Court.

These terms, which should be incorporated either into stipulations or into a decree, are for Option B, as follows:

First: That the defendants, the State of New Jersey and the Passaic Valley Sewerage Commissioners, are hereby permitted to discharge the purified effluent from its sewage disposal works situated on the Newark Meadows, through its effluent tunnel extending from the said sewage disposal works to Robbins Reef and through its discharging and diffusion system under New York Bay into the waters of New York Bay as its proposed dispersion area near Robbins Reef; subject, however, to the conditions stated in the following sections:

Second: That the effluent discharged from the sewage disposal works on Newark Meadows, before entering the outfall tunnel leading to the dispersion area near Robbins Reef, shall at all times have been purified by the said sewage disposal system to a degree of purification expressed by the following:

(*a*) The total suspended matter in the effluent, on entering the outfall tunnel, shall be no more than 25 per cent of the total
1054 suspended matter of the sewage entering the sewage disposal system from the Trunk Sewer Tunnel;

(*b*) The total organic matter in the effluent, on entering the outfall tunnel, shall be not more than 50 per cent of the total organic matter of the sewage entering the sewage disposal system from the Trunk Sewer Tunnel;

(*c*) The total putrescible matter in the effluent, on entering the outfall tunnel, shall be not more than 60 per cent of the total putrescible matter of the sewage entering the sewage disposal system from the Trunk Sewer Tunnel.

Third: That the defendants shall not be permitted to begin the discharge of effluent or sewage into New York Bay at its dispersion area near Robbins Reef, or at any other point, until the adequacy of the Passaic Valley Sewage Disposal System on Newark Meadows to secure and maintain, fully and continuously, the degree of purification of the sewage expressed in section "Second," has been affirmatively determined and reported to the Court by an inspector, who shall be a competent and skilled sanitary expert, to be appointed by the Court.

Fourth: (*d*) That the actual compliance with the requirements as to the degree of purification of the effluent from the sewage disposal works on Newark Meadows before entering the outfall tunnel, as expressed in section "Second," shall be determined by the above-mentioned Inspector appointed by the Court, at intervals not
1055 exceeding thirty days during the first six months after the plant is put into operation;

(*e*) That if, as the result of such inspection, it is determined by the Inspector appointed by the Court that the sewage disposal works as constructed and in operation are inadequate to secure fully and continuously the degree of purification, expressed in section "Second," the defendants, on being notified of this fact by the Court, shall immediately proceed to improve or increase the means of purification of its sewage disposal works to such extent as will secure the degree of purification expressed in Section "Second";

(*f*) That after the Inspector appointed by the Court shall have found for three successive inspections, at intervals of not less than ten days apart, that the degree of purification, expressed in section "Second," is being fully and continuously secured, the period of times between inspections may be increased to not more than ninety days.

(*g*) That whenever any person has reason to believe that the degree of purification of the effluent, expressed in section "Second," is not being fully or continuously secured, such person may file, with the Inspector appointed by the Court, a request for an additional inspection together with grounds on which the request is made. If the Inspector considers the request and the grounds therefor
1056 to be proper and sufficient, he may thereupon make such inspection or inspections as will enable him to determine the degree of purification of the effluent then being secured by the sewage disposal works, and shall take the same action thereon as would have been taken following one of the regular periodic inspections;

(*h*) That the reasonable cost of the services and expenses of the Inspector appointed by the Court shall be paid quarterly to the Clerk of the United States Supreme Court by the defendants.

Fifth: That whenever the Court may become satisfied from a report of its official inspector, or from other reliable source, and after giving opportunity for public hearings and for receiving and considering further evidence, that the public interests demand that the

degree of purification of the sewage disposal effluent, before entering the outfall tunnel, should be increased, the Court may prescribe such additional degrees of purification and such features of purification, additional to those now stated in section "Second," as may be necessary and adequate to protect the navigation, commercial, sanitary, and property interests of the public. When so prescribed, modified requirements embodying such additional degrees and features of purification, shall be substituted for and take the place of those now expressed in section "Second."

1057 Sixth: That if the sludge or the screenings from the Passaic Valley Sewage Disposal Works be disposed of by dumping at sea, the dumping shall not take place within five miles of the nearest point of land lying within the State of New York.

Seventh: That the terms of these stipulations (or decree) shall be binding on the successor or successors of the Passaic Valley Sewerage Commissioners, under whatever name or form such successor or successors shall be constituted.

Q. Prof. Landreth, in preparing and offering these two alternative sets of recommendations which you have designated respectively as Option A and Option B, as suggested practicable modifications of the proposed Passaic Valley Sewage Disposal System, for the purpose of lessening the alleged polluting effect of the effluent from such sewage disposal system upon the waters of New York Harbor, what facts and conditions relative to the New York Harbor and adjacent waters have you taken into consideration?

Mr. Riker: The question is objected to as immaterial and irrelevant. The order of March 10, 1919, dealing only with practicable conditional arrangements that may be introduced into the Passaic Valley Sewage System.

The Commissioner: Note the objection of counsel for the defendants.

1058 A. I have taken into consideration the following facts:

First: That the Metropolitan District of New York, regardless of state boundaries, constitutes the largest city of the world;

Second: that this largest and growing city is characteristically a maritime district, surrounded and intersected by the waters of New York Harbor and by its numerous ramifying connected tributaries immediately adjacent thereto;

Third: That beside being the greatest residential district, it is also the greatest commercial port of the world and the greatest seat of manufacturing and commercial industry of the world, and is rapidly increasing in both population, industry and commerce;

Fourth: That notwithstanding the fact that this great district is a maritime district, it is nevertheless a land-locked maritime district with few and restricted tidal inlets or connections to the sea, namely, at the Narrows, Arthur Kill, Throgs Neck, and Jamaica Inlet;

Fifth: That the small number and restricted widths of the tidal inlets from the sea to this extensive and important system of harbor ramifications, is highly unfavorable to the prompt and effective natural dispersion of the inevitable pollution which is incident to the immense population, industry and commerce of the port;

Sixth: That every intelligent scientific forecast of future
1059 conditions indicates that the resultant pollution of the harbor and its adjacent waters is annually increasing and must soon reach a degree of severity which will surely react seriously, if not disastrously, upon the welfare of this important cosmopolitan city and port;

Seventh: That every known available means should be employed to lessen, by both preventive and remedial measures, the already existing serious pollution, and the far worse degree of pollution of the harbor and adjacent waters which we are rapidly approaching;

Eighth: That the State and the City of New York, appreciating the seriousness of the situation and the disastrous results of a continuation of an increase in harbor pollution, upon its social, commercial and sanitary interests, have for several years taken active and energetic steps to provide for Greater New York a system of sewage disposal which shall very greatly reduce that portion of the harbor pollution which emanates from Greater New York;

Ninth: That definite plans for such sewage disposal improvements, for the several Boroughs of Greater New York, have been tentatively prepared after several years of careful investigation and only await formal consideration and adoption, and the perfecting of administrative and financial means of putting these plans into execution;

Tenth: That a Constitutional obstacle to the providing of
1060 adequate funds now exists, and that a program by which this obstacle may be removed has been partially perfected and is soon to be put in operation;

Eleventh: That when this obstacle to the provision of necessary funds has been removed and the plans for sewage disposal improvements have been formally adopted and put into constructive execution, the City of New York will have entered on the most extensive and advanced sewage disposal undertaking in the world, the beneficial results of which in the rapidly diminishing pollution of the New York Harbor will soon follow;

Twelfth: That under the above conditions, and with a full appreciation of the difficulties which Greater New York has had to combat, and with the bright prospects that New York will in the very near future be enabled to secure, from its sewage disposal improvements, a definite and substantial reduction of harbor pollution, it seems unwise and an inconsistent proposal that the sister commonwealth of New Jersey, almost equally interested with New York in the welfare of the harbor and port, should at this time seriously propose a measure the result of which will be directly opposite to the beneficial results

of a diminution in harbor pollution which Greater New York is about to initiate.

Dr. O'Sullivan: Your witness, Mr. Riker.

1061 Cross-examination.

By Mr. Riker:

Q. Mr. Landreth, at the end of your testimony you have been telling us of the great work that the State of New York and the City of New York has undertaken to do in the way of purifying their sewage. Will you tell us just what that is.

A. That consisted first in the laying out of a most extensive system of investigations. It was appreciated that the problems to be met and solved by the City of New York in this undertaking, were serious and enormous, and that no undertaking should be entered upon until the whole problem had been most thoroughly investigated, and the best solutions considered and adopted. The problems were not only of a sanitary nature, but were of a social nature, a political nature and a constitutional nature.

The City has already undertaken, and quite largely completed, its investigations as to the technical ways of meeting the problem. It has already some time since, been considering and taking tentative preliminary steps towards the meeting of the other difficulties.

Q. Yes; but what I am asking for, Professor, if you will devote your attention to it, is the plan of purification which they have undertaken, if you know.

A. You mean the technical types of sewage disposal?

Q. Yes, that is what I mean.

A. Yes, they are various.

1062 Q. Tell us what they are.

A. The City being located, as I have explained, on numerous portions of land intersected by harbor ramifications, can not assemble any one single system, any single unit of purification works, which will treat them all. Moreover, the character of the sewage from these different pollutions, being different, requires different treatment. The degree of existing pollution calls for more immediate and more urgent and more extensive purification in some places than in others, and all this goes to make a single sewage disposal system, such as the Passaic Valley has undertaken for us, impossible. In place thereof there will have to be substituted a variety of units, one for this locality—and when I say locality, I am speaking particularly of the locality as determined by the abounding drainage area lines and intersecting waters, both of which become obstacles in separating that community from another community. You can not flow sewage over a watershed line, and you can not very well flow it across the mouth of the harbor; so I say first that this disposal system of New York must necessarily be a number of disposal units, each one appropriated to the particular local problem concerned.

Now, these disposal units are also being planned so that they may be constructively put in operation as partial remedies, even before the entire proposal is complete. That is highly desirable. It
1063 will be a matter of years to complete any one complete system for New York.

Q. Can not you answer my question—what they propose to do?

A. I am answering it just as rapidly as I can.

Q. Instead of what they might do, tell us what they propose to do.

A. I have an understanding of the difficulties of the question, and I propose to answer it in the way I am doing now.

Q. Tell us what is the proposed purification for the Greater City of New York——

A. As I have just said, a number of purifications, different plans.

Q. For the Hudson front of Manhattan Island?

A. For the Hudson front of Manhattan Island, the proposed scheme of purification is a number of local purification stations, which ultimately may be connected up into a larger system, but which, for the immediate relief of the present or the near future, shall consist of purification at those points by screening and by sedimentation, or by further treatment, as the different plans call for.

Q. Do you not know that the plans have been presented and approved and adopted?

A. In some places they have, yes.

Q. Well, what are those plans that have been presented and approved and adopted, if you know?

A. They consist, as I say, in present treatment, by screening and by sedimentation.

1064 Q. Where is the sedimentation proposed to be applied at, what points?

A. At some of these points of sewage disposal.

Q. What ones?

A. (No reply.)

Q. You do not know of your own recollection, Professor?

A. I know generally.

Q. Well, state generally how many; how many on the Hudson River front are proposed to be sedimentation plants?

A. Well, these plants on the Hudson River are all intended to be screening stations, and at all of those there will be some measure or degree of sedimentation.

Q. Are you sure of that?

A. Yes; depending on the volume and the capacity of the basins containing the screens.

Q. Do you know whether such plans have been prepared and adopted?

A. Some of them have.

Q. What ones?

A. I can not answer that without referring to the records of the Board of Estimate.

Q. How many?

A. Do you refer to those on the Hudson?

Q. That is what we are talking about.

A. I can not say. I know that at one of these, the one of Dyckman Street that has been adopted and constructed.

Q. What type of purification?

A. That is screening, largely.

Q. Any sedimentation at all?

A. There will be some sedimentation there.

Q. Are you sure of that?

A. Yes.

1065 Q. Have you seen it?

A. Not the plant itself.

Q. Would you set up your recollection against the evidence of Mr. Kenneth Allen?

A. No.

Q. What is the removal by screening of the processes that are applied at Dyckman Street, and are proposed to be applied at the other Hudson River disposal plants?

A. I shall have to consult the exhibits in the case before answering that quantitively.

Q. Why can not you answer about mechanical removal by screening, can not you answer that?

A. I can answer it from the results which have been obtained in the past.

Q. Well, what are they?

A. That reaches as high as 80 or 90 per cent.

Q. Do you think that screening can be applied to sewage from 80 or 90 per cent of suspended matter?

A. I think it has been done.

Q. Where?

A. Right here, at some of these plants.

Q. What ones of these plants are you speaking of?

A. It has been done at ——

Q. What are you referring to, Professor?

A. I am referring to Complainants' Exhibit No. 244.

Q. Prepared by you?

A. No.

Q. Did you make the determination?

A. No.

Q. Do you know anything about that?

A. Except they are in evidence, and except that I have understood the results——

1066 Q. Is that all you know about removal by screening?

Dr. O'Sullivan: One moment; finish your answer.

The Witness: I know the results of these tests from discussion with the engineers who made them.

Q. You know about them?

A. And my examination of the exhibits, and by the reports on the work accomplished.

Q. Have you ever operated a plant which removed 80 per cent of the solids?

A. No; I have seen a plant operate that did remove it.

Q. Can you say what?

A. I have inspected official plans which have removed that amount of solids.

Q. How do you know?

A. Because I examined the results of the chemical tests which have been made.

Q. What kind of a plant was that?

A. The one plant I had in mind was a septic tank plant with filtration.

Q. You were being interrogated on the subject of screening plants, Professor?

A. Yes.

Q. Is that a septic plant?

A. You asked me if I had ever known of a plant where 80 per cent had been removed.

Q. I did not ask you that. I asked you—my entire examination was directed to the screening plants on the Hudson River, and an inquiry as to what per cent. you expected to be removed by screening at all. Now, how much do you expect to remove by a screening plant, of solids?

A. I have not formed any expectation.

1067 Q. How much do you know has ever been removed by a screening plant?

A. I answered before that they have been removed as high as 92½ per cent.

Q. Where?

A. At the Dyckman Street plant.

Q. As a practical operation of the plant, on an average they have removed 98 per cent, have they?

A. This was just a test. They did not analyze it daily under average conditions. They tested it under average conditions, but this was not the result of the average conditions. It was the result of a test under ordinary favorable conditions.

Q. Have you ever operated a screening plant?

A. No, but I have been officialy connected with plants that were operated.

Q. You have been officially connected—what do you mean; and in what official capacity?

A. In the capacity of Consulting Engineer.

Q. Where were they operated?

A. They operated in Rochester, New York. I was officially connected with the State Department of Health when these plants when they were first negotiated. I terminated my connection with the Board before they were actually put into operation.

Q. Did you have anything to do with the operation?

Dr. O'Sullivan: Let him finish his answer.

Q. I am perfectly willing, if I can determine when he is through. I had difficulty because he appeared to have finished what he had to say. Go ahead.

1068 A. (Continuing:) I had to do with the original conception of the plans, and their approval and adoption, but I terminated my connection with the department before they were actually built, and therefore before they were operated.

Q. That does not answer that question, Professor. Have you had any screening plant under your operation officially?

A. Under my observation directly, no, because I have not been operating those screening plants.

Q. Do you know of any screening plant which removes in operation 75 per cent of the suspended solids?

A. I can not refer to any plants where by screening alone, that has been done.

Q. I am asking you about plants which involve screening only.

A. No, I cannot.

Q. Have you ever heard of any such a plant?

A. I am referring to this one at Dyckman Street, where even a larger per cent than that has been removed.

Q. In actual operation?

A. In actual operation.

Q. The average removal is greater than 80 per cent, is it, at Dyckman Street?

A. Well, I have explained that this might not be called average operation. It was operated under average conditions, but not operated continuously day after day, and the average resulted added up and divided by a number.

Q. Now, the screening plants on the Manhattan shore of the Hudson River then, are calculated and designed to remove 80 per cent of the solid suspended matter, are they?

1069 A. I have not said that.

Q. I asked you whether they are.

A. I do not think they are.

Q. What are they calculated to remove?

A. The screens alone?

Q. Yes; and grit chambers, yes.

A. You mean under their present contemplated——

Q. Under the plans that are adopted, Prof. Landreth.

A. I will reiterate again, the plans adopted now are plans which are intended later, as can be done, to merge into larger and more compelte plans.

Q. I am asking you about the plans which you say have been adopted, Professor. Do you know what they are thought to be capable of removing in the way of suspended solids?

A. They expect to remove in the neighborhood of 50 or 60 per cent by the sedimentation and screening together.

Q. I did not ask you about sedimentation. There is only one plant, according to your testimony, that is sedimentation. I am asking you about the grit chamber and screening plants. What is the removal plan contemplated by those processes for the sewage that is discharged along the Manhattan front of the Hudson River.

A. I shall have to refer to the plans themselves and to the re-

ports on which they were adopted before giving you the quantitative values, the limits.

1070 Q. Are they designed for 75 per cent of the suspended matter?

A. I presume they are not, by screening alone.

Q. Grit chambers and screens I am speaking of, Professor. Are those plans designed to remove 75 per cent of the suspended solid matter?

A. I presume they are not.

Q. How much are they designed for?

A. I have already answered.

Q. Answer again, please.

A. In the vicinity of 50 or 60 per cent is expected to be removed.

Q. Did you hear the testimony of Kenneth Allen?

A. I did not.

Q. You do not know what he said about the intended expected removal of solids?

A. No.

Q. 50 to 60 per cent; will that remove 60 per cent of the putrescible matter?

A. No, I judge not.

Q. What removal of the suspended solids will remove 60 per cent of the putrescible matter?

A. That can not be answered in the terms of one single ratio.

Q. Well, give me the highest ratio that you know, that will involve the removal of 60 per cent of putrescible matter.

A. That depends on the age of the sewage. If it is fresh sewage and the screening is effective, it will remove a much larger percentage of the putrescible matter than if it is stale and septic.

1071 Q. Will you answer the question, assuming the most favorable conditions, what removal of solids will be required in order to remove 60 per cent of the putrescible matter?

A. I should have to make that something of an estimate, simply a guess, because I have not addressed myself to that particular value at ratio, and could answer it better after consulting the results of operation of——

Q. Have you finished?

A. No; the results of the operation of the plants where that has been measured. I should say, however, that it would require a removal of upwards of 80 per cent. Then, however, it would depend very much on the state of the sewers.

Q. Why have you not considered it when you want to introduce it into a condition as a condition for the operation of the Passaic Valley sewers?

A. Because the conditions are very different. The Passaic Valley sewer is not to be confined to screening alone, nor to grit chambers; in fact, you have not used any grit chambers, so far as I could ascertain, but you have and are required to use extensive detention basins, which are the most effective means of removal of the suspended solids, and that you exclude from your question the temporary plants along the Hudson River.

Q. No, I have not excluded it. I asked you what percentage of total suspended matters under more favorable conditions of age and length of flow of the sewage it would be necessary to remove in order to remove 60 per cent of the putrescible matter.

1072 A. By screening alone?

Q. No, I did not ask you about screening alone. I ask you now a plain question as to the percentage of solid matters you would have to remove in order to remove 60 per cent of the putrescible matter.

A. My answer to the other will apply even more safely to this, that probably 80 per cent.

The Commissioner: Gentlemen, the hour for adjournment has arrived. We will resume our session tomorrow morning at ten-thirty.

(Whereupon, an adjournment was taken to tomorrow, Wednesday, August 13th, 1919, at 10:30 a. m.)

1073 Fifth Day, August 13th, 1919.

Municipal Building, New York City,
August 13th, 1919, 10:30 a. m.

Present: Parties as before.

OLIN H. LANDRETH was recalled.

Cross-examination (continued).

By Mr. Riker:

Q. I was inquiring last evening as to the proposed treatment given to the New York sewage on the Hudson shore of Manhattan Island. Have you since the last session refreshed your memory in any way as to what treatment is proposed to be given to that sewage?

A. I have not had a chance to see Mr. Allen at all since the session yesterday, and he is the man on whom I depended to know, and represent the situation, as to the approval of the plans, as to the introduction of those plans, so that I can not say any more today virtually than I could yesterday.

Q. What part have you had in the preparation of the plans in question for the treatment of the sewage on the Manhattan shore of the Hudson River?

A. I had no part in the preparation of the plans for the treatment of sewage for New York.

Q. So that all you know about it is from statements made by others?

1074 A. Yes, and my examination of what actually exists.

Q. So far as I recall your testimony, you did not say that this particular sewage, that is, on the Manhattan shore of the Hudson

River, is to be treated in any other way than fine screening and sedimentation, did you?

A. For the present, I think that is all that is intended, but I think I endeavored to make it plain yesterday that in very many of the individual separated plants being planned and adopted for New York, it is the intention to put them into operation just as rapidly as possible, and therefore, while they can only extend to partial treatment, that just as rapidly as the obstacles of enlarged construction can be overcome, these will be improved and united more or less into larger plants, and where more extensive treatment can be given, if necessary.

Q. What authority have you for that statement, Prof. Landreth?

A. My general reading of the reports and my conversations with the engineers and with the officials of the City and with the people who have been investigating, of which I was one, for a time, the general policy for the betterment of New York Harbor, so far as it comes from Greater New York City. We adopted as one of the earlier points of an established policy, that whatever ultimate treatment should be necessary, and a high degree of treatment was
1075 anticipated, it should be adopted so as to be of immediate and temporary use and then enlarged, and then extended to more extensive treatment later, when the funds would permit and when the demands required it.

Q. Is that an official action that you are speaking of?

A. More or less official. It is the action of officials, yes, and in some cases, it has been officially acted on, as for example, in the approval of the plan for one of the East River outlets. The plan went so far as to discharge into the East River, as approved today. The plan ultimately will be to extend that point of discharge to Rikers or Wards Island, and there to provide further treatment, but we do not wish to wait and hold the plans back long enough for that future, ultimate, permanent degree of treatment, and wanted to put it into operation at the earliest possible date, so those are progressive plans, plans that can be extended.

Q. Do I understand you to say that by official action there has been adopted a temporary plan, for immediate use, and a future plan for ultimate use?

A. I mean to say that so far as for temporary and immediate use it has been adopted, and so far as for future use, it has not been adopted, because there are two alternate ways, one of which may seem to be the better, when we get where we can, to extend that. It would be foolish, therefore, to adopt it now, and have to take it back.

1076 Q. You say when "we." Who do you mean by "we"?

A. I am speaking collectively of the City of New York.

Q. Don't you know that the plans as submitted and adopted have been testified to by Mr. Allen as sufficient for the treatment of the sewage in New York up to the year 1960, and in his opinion indefinitely thereafter?

A. I do not know how far he expressed his own opinion on those

matters, and how far he undertook to express the opinion of the officials of the City. I have not read his testimony.

Q. Have you not said that he is one that you relied upon for your information and your acquaintance with the plans for the treatment of the sewage of New York?

A. Not for my information. I said I relied upon him to introduce into evidence the necessary information.

Q. Are you in charge of this case?

A. No, sir, by no means.

Q. What do you mean when you say you relied upon him for the introduction of testimony?

A. I knew that he was assigned to that work, and I did not, therefore, interfere, or undertake it myself.

Q. So far as the Manhattan side of the Hudson River is concerned, do you know of the adoption and approval of any plans which involve the treatment of the sewage discharged along that front, by any other process than fine screening and sedimentation?

1077 A. I do not for the present, and the present is all that we adopt for.

Q. And when I asked you whether you knew of any being adopted, I intended to say for the present or the future. Do you mean to say there have been any adopted for the future?

A. I stated there were those for the East River.

Q. I am asking you for the Hudson River, the shore of Manhattan Island.

A. I repeat my statement made as to the East River, namely, that the adoptions are made step by step as the work is ready for provision of funds and execution of work. It is not adopted beyond that. Even though the City may contemplate and informally consider the way out, it does not officially adopt it until the work is about ready to be executed.

Q. How long have you been teaching, Professor?

A. Since 1879.

Q. What aged students or scholars have you taught?

A. Scholars from 16 years of age to 50.

Q. Now, I again ask you what plans have been adopted for the treatment of sewage now being described from Manhattan Island on the Hudson River side, other than fine screening and sedimentation?

A. I do not know that any have been officially adopted, although it is possible they have, without my knowledge.

Q. Now, for the sewage which discharges into the Harlem River, what plans have been adopted, if you know?

1078 A. The principal relief to the Harlem River from its present high pollution has been attempted to be in the direction of diverting the sewage away from the Harlem River into other streams, and not to provide for the present, as I understand, immediate works on the Harlem. An extensive intercepting sewer is planned for the east side of the Harlem, and also for the west side, and that intercepting sewer system is planned to carry the sewage through a tunnel into treatment works on the Hudson Shore, the

west side of Manhattan Island. That forms the principal relief for the present pollution of the Harlem River.

Q. What treatment is contemplated in those plans for the sewage thus collected at the treatment works?

A. Grit basins and screening.

Q. Anything else?

A. I believe not for the present, nothing has been adopted beyond that.

Q. What disposal is planned and adopted for the Harlem River shore of the Borough of the Bronx?

A. What I have said just now relates to the Manhattan shore of the Harlem, as well as the Bronx part of the Harlem, an intercepting sewer, as I stated, running along each side of the Harlem, one on the Manhattan side and one on the Bronx side, and the sewage from these two intercepting sewers is for the present planned to be carried through a tunnel onto the Hudson shore. That scheme, however, lends itself to a much larger enterprise for more ex-
1079 tensive purification later when, if it should be decided, and it is a matter of time, I think, when it will be, a great interceptor will be carried down substantially along the line of the East River, and when that is done, this sewage from the two intercepting sewers flanking the Harlem River can then be diverted away from the Hudson and into this large outlet tunnel sewer running south.

Q. You are prophesying now, are you not, professor?

A. No. I am not prophesying. I am stating that as a fact, the fact that is feasible of execution in that manner.

Q. Now, will you answer my previous question. I did not ask you about the Harlem shore of the Bronx; I asked you about the Hudson shore of the Borough of the Bronx. What treatment is planned and adopted for that sewage?

A. The Hudson shore of the Bronx?

Q. Yes, that is what I said.

A. There is an intercepting sewer planned for that district, to have sedimentation and screening works north of Spuyten Duyvil.

Q. Is there anything else that is planned for that district?

A. I do not know of anything; from my own knowledge I can not say of anything else.

Q. Is the Dyckman Street plant in that district?

A. No.

Q. Where is it?

A. That is on the Hudson front of the Manhattan side.

Q. I further asked if any are planned for the relief of
1080 the Harlem River than those which you have testified to as constituting two intercepters uniting through a tunnel at the disposal works to discharge to the Hudson River?

A. I have already mentioned a sewer running along the East River which ultimately will discharge to Ward's Island, and that also extends up into the Harlem district, and will furnish for part of its length relief to the Harlem River as well as to the East River.

Q. What treatment will be given to that sewage?

A. It is settlement and screening.

Q. Has any other treatment been planned and adopted for that sewage?

A. Other treatment has been considered but not yet planned and adopted.

Q. Considered by whom?

A. By the Metropolitan Sewerage Commission; by the Bureau of Sewer Plan of the City of Greater New York, and in the form of reports, the matter has been before the Board of Estimate.

Q. And not adopted?

A. It has not yet.

Q. Now, what plans have been submitted and adopted for the relief of the Brooklyn shore, Long Island shore, of the East River?

A. Well, there are several large intercepting sewer projects planned.

Q. And adopted?

A. Some of them have been adopted; some adopted by the Bureau of Sewer Plan, but not yet by the Board of Estimate. I can not tell you just where the official adoptions extends in each case.

1081 Q. What treatment do these plans involve for the sewage?

A. My understanding is they employ sedimentation and screening.

Q. Anything else?

A. Not so far as I know. I do not think anything beyond that has been as yet adopted.

Q. What plan has been submitted and adopted for the relief of the Manhattan Island shore of the East River?

A. There the relief takes the shape of the trunk sewer above referred to which will discharge at Wards or Rikers Island, and below that a number of treatment stations at the points of existing large trunk sewers.

Q. What kind of treatment?

A. Screening and sedimentation.

Q. For the lower East River on the Brooklyn shore, is there not another plan submitted for the disposal of that sewage?

A. Yes.

Q. What is that plan?

A. That is a trunk sewer extending down along the south shore, along the east shore of the East River, in South Brooklyn down and extending to a point in the Upper Bay.

Q. Opposite Red Hook?

A. Yes.

Q. What treatment is planned to be given to the sewerage in question?

A. I think that is to be a fairly extensive treatment. I can not say in detail just what that is, however.

Q. Don't you know it is confined to sedimentation and

1082 screening?

A. I do not.

Q. Do you know what quantity of sewage it is planned to discharge at this point?

A. I do not carry it in mind. I have the data here somewhere separate.

Q. 200,000,000 gallons per day?

A. It may be as much as that. I do not think it is, however.

Q. Now, are these extensive and comprehensive plans and projects of the Greater City of New York the ones to which you alluded in your direct examination?

A. I do not quite know how to interpret your word "these."

Q. Well, the ones that you have gone over, the ones that have been planned and adopted for the Greater City of New York.

A. No, these do not.

Q. What else is there that has been planned and adopted?

A. Nothing else has been planned and adopted, so far as I know, beyond what I have said; but that does not fill out the full meaning of what I stated in my testimony, and to which you have just referred, I presume, when you speak of extensive sewer plans. There are many extensive sewer plans and projects which are not yet adopted, many of which will almost certainly be adopted, but have not yet.

Q. Are you now making that statement as a prophecy, or something that has been determined upon?

A. I am stating it as a statement of facts in part, and a statement of my own opinion as to what will take place, in other

1083 part.

Q. What is the statement of fact, what part is the statement of fact in that opinion?

A. The statement of fact is that it is the policy of the City of New York, even where extensive plans are intended, not to adopt all of them, but those portions which are most immediately within reach of execution. There are difficulties in adopting something which is not to be immediately constructed, or constructed in the near future.

Q. That constitutes good intentions, does it not, that is all it is?

A. Well, it is good intentions—that would be a mild expression for it, I suppose, but it is more than that, though.

Q. If Mr. Kenneth Allen has stated on the witness stand in this case that the plans which have been enumerated, and which you have now referred to, are put into operation, it would be sufficient to care for the sewage of the Greater City of New York to the year 1960?

Dr. O'Sullivan: That question is objected to on the ground that it does not represent the testimony of Mr. Allen, for he gave far more comprehensive plans for future, showing disposal and other methods of dealing with problems in the future.

The Commissioner: Note the objection of counsel for the complainant.

A. That is a condition "if." I do not see where the ques-

1084 tion is there.

Q. You do not agree with him—if he testified to it?

A. You have asked the question; you say "if" so-and-so.

Q. I have asked you if he has testified in that way, do you agree with him?

A. No.

Q. You do not agree with him?

A. If he has testified that the plans which have been referred to, and have been referred to for immediate adoption will be adequate for New York future sewerage, I do not agree with him and I do not think he intended to say that.

Q. I asked you whether you agree with him if he said that?

A. If he said that, confining his estimate of sufficiency to those which have been at present adopted, I certainly do not agree with him, but I do not think he said that.

Q. Are you in the employ of the City of New York in any capacity, except as expert witness in this case?

A. No, sir.

Q. How long is it since you have been in the employ of any Department or Bureau of the City of New York?

A. I have not been employed by the City of New York, for, I think, it is two years.

Q. And when you were employed, what was your official position?

A. My last employment, I think, by the City was in connection with some litigation on Staten Island, relative to discharge of some of the sewers or the construction of some of the sewers there. About that same time I was employed by the City in the consid-
1085 eration of plans for a hospital or other public buildings on Mohansic Watershed, but whether it was before or after that Staten Island engagement, I do not now recall.

Q. What percentage of the total solids of the sewage of the Greater City of New York will be removed by the processes of fine screening and sedimentation which have been submitted and adopted?

A. I can not say what would be the result of the average operation.

Q. Can you place any limit on it?

A. Yes, I can place limits.

Q. Will you place a limit?

A. Limits of from nothing up to 80 or 90 per cent.

Q. What percentage of removal will be accomplished by the works of the Passaic Valley Sewerage Commissioners?

A. Mr. Fuller testifies——

Q. I am asking you, please, not what Mr. Fuller testified to.

Dr. O'Sullivan: One moment. I move that this witness be permitted to answer intelligently in his own way.

Mr. Riker: I suggest that this witness answer the questions that are asked, and not answer questions that have no been asked.

Dr. O'Sullivan: Answer in your own way, Professor.

1086 A. My only opinion as to what the Passaic Valley works will do is based on Mr. Fuller's candid and very distinct statement in his testimony in these present hearings, in which he says that the works, that the improvements, will remove from 50 to 60 per cent solids; but that improvements by retarding the ve-

localities, there is no room for doubt that it will remove 60 per cent, and that by the introduction of his plan for treating the sewage with precipitating chemicals, the removal will amount to 85 per cent.

Q. You have no way of determining the removal yourself, without accepting somebody else's estimate, then?

A. I have made no study of the New Jersey situation on that point, which is any more definite than Mr. Fuller's testimony.

Q. Well, have you reached the same result from your independent studies?

A. I have not been in possession of sufficient data to reach a close individual opinion as to that.

Q. How do you accept Mr. Fuller's estimate, then?

A. Because it bears distinctly on the question that we are concerned with, namely, one of the standards to apply to the outfall of the Passaic Valley system, and because Mr. Fuller has given recent and doubtless careful attention to the matter, and has testified very definitely, and I have therefore accepted his statement.

Q. You have accepted his statement merely because he has made it; is that what you mean to say?

A. Well, I should not accept it if he had not made it.

1087 Q. Is that the best answer you can give to that question?

A. I think that is the answer. I accepted it because he made it.

Q. Not because you had any knowledge of your own which confirmed it?

A. Not knowledge of such detail and study as Mr. Fuller has evidently given it, and therefore I should not like to have it set up in opposition to Mr. Fuller's opinion, or in corroboration of it, either.

Q. And you are equally without data or knowledge about which you would testify to the amount of removal of solids which would be accomplished by the proposed and adopted plans for the treatment of the New York sewage?

A. Yes, in part, but there I have repeatedly stated the New York plan is different from the Passaic Valley plan. The New York plan is a progressive plan, to be done step by step. The Passaic Valley plan proposes something of definite accomplishment, and does nothing more than that.

Q. Do I understand you, Professor, that you mean to say that the plans adopted by New York are not definite plans?

A. No, by no means.

Q. I am asking you what percentage of removal of solids would be accomplished by the plans adopted? What will it be, if you can testify to it?

A. As I have stated, I can not say what they will be in practice.

1088 Q. Why can not you?

A. Why, I have not formed any accurate estimate of that, because I have depended on the engineers who are planning that, who are far more competent by reason of their familiarity with the

details of the problem to estimate that. I know what is possible to be done, however, and I have stated the limits in answer to your question as to what the limits would be.

Q. You answered my question as to the limits. I now ask you again whether you can state not the limits, but the probable removal of solids by the plans adopted by the City of New York for the treatment of its sewage?

A. I can not, any closer.

Q. Then when you expressed a combination of the plans of the City of New York, you did it without knowing what they would accomplish, did you?

A. I did not do it without knowing what it could accomplish and can accomplish and may be made to accomplish, but what it will accomplish depends on operation, and I can not tell what that will be.

Q. So that your combination was not upon plans adopted but upon what might be done in the future, was it not?

A. It included that. It included the extension as to what might be done in the future, yes.

Q. So far as you know, can the City of New York put the plans which have been adopted, into operation?

A. But what does your word "can" apply to? Do you
1089 mean financially or physically?

Q. Is the City of New York able to do it?

A. The City of New York is able to do it as gradually probably, as the physical construction can be carried out.

Q. Is there anything prohibitive to the carrying out of the scheme, so far as the actual construction of the work is concerned?

A. The furnishing of funds which must be taken out of an income which has many other demands on it, constitutes one of the difficulties, and only a certain amount of money under the present charter can be appropriated for sewer purposes, and I think the record will show that that has been fairly extensive in the recent past few years, and I think it is the intended policy to continue that matter of expenditures. Just the greatest amount that can be diverted from other things and that as soon as the obstacles in the charter can be avoided, then, very large amounts will become available.

Q. I repeat the question.

A. I have given my answer.

Q. That is all you have to say in answer to that question?

A. The things that prevent the carrying out are those which I have referred to—primarily, the making available of adequate funds.

Q. What is the population of the Greater City of New York which contributes sewage to the Upper Bay, directly or indirectly, at the present time?

A. By "indirectly," I suppose you mean into the Hudson
1090 and into the Upper Bay?

Q. I mean that and the East River also and the Harlem.

A. Something over five million people.

Q. What is the volume of the sewage estimated to be, if you know?

A. About 660,000,000 gallons.

Q. That is your estimate?

A. Yes.

Q. Do you know whether or not that conforms to the estimate of Mr. Kenneth Allen?

A. I am taking this from an exhibit, and I understand that that exhibit was used by Mr. Allen. This is an estimate prepared in the office of the Board of Estimate and Apportionment in their Engineering Bureau.

Q. Then you do not know whether your estimate conforms to his?

A. I do not, but I think it does.

Q. Why do you think so?

A. Because I think he used this exhibit in his testimony.

Q. Now, Professor, do you think that the discharge of the sewage of over five million inhabitants, amounting to 660,000,000 gallons a day, according to your estimate, with no treatment other than sedimentation and fine screening, will relieve the waters about the Greater City of New York from nuisances, so far as sewage pollution is concerned?

A. I understand the reading of the question, but I do not quite see what is intended by the wording of it. I do not quite
1091 get the point desired in an answer.

(The question was repeated as recorded.)

The Witness: I do not think the discharge of any appreciable amount of sewage will relieve the waters.

Q. Will the treatment by sedimentation and fine screening of the sewage of the Greater City of New York, estimated by you as 660,000,000 gallons per diem, and the discharge of the effluent produced by these treatments, relieve the waters about the Greater City of New York from sewage pollution?

A. If you mean to ask whether the treatment proposed to be applied to this sewage will relieve the waters, I can give an opinion of that. That is not the form the question takes.

Q. You can not answer the question as put?

A. I have already answered it.

Q. Will the treatment of the sewage of the Greater City of New York, amounting to 660,000,000 gallons a day by sedimentation and fine screening produce an effluent which, when discharged into the waters of New York Bay and other waters about the Greater City of New York, produce a nuisance?

A. They will produce a condition decidedly better than at present, better than the present condition. If the present condition is a nuisance, then these will relieve the nuisance. The present situation is a nuisance at certain points, and plans have been adopted with reference to the curing of the defects of the most
1092 seriously polluted points first.

Q. So that in your opinion, after the method as adopted

has been put into operation, no nuisance will exist, so far as the sewage of New York produces them in the waters surrounding the City of New York?

A. I do not think my answer is in that form.

Q. Well, what is your answer to that question?

A. (Answer repeated). Have you reference to the plans and only those which have been adopted?

Q. That is what I said.

A. I do not think these will entirely cure all the nuisances.

Q. Where will nuisances continue to exist?

A. I think the nuisances which exist now will be ameliorated in many points, but I think there will still remain nuisances in the more congested points, in portions of the Harlem River, but more especially at points in Brooklyn, as around Gowanus Bay, and in the Wallabout Basin, and Newton Creek. I think that possibly if the improvement is confined to the plans already adopted, that they still will have some nuisances. I do not understand, however, that the City contemplates stopping its sewage treatment activities with the list of plans which are now actually adopted.

Q. You say you still think there will still be a nuisance in the Harlem River. Do you not know that the plan contemplates the diversion of all the sewage from the Harlem River?

1693 A. It contemplates the diversion of a large part of it but that has not yet been officially adopted.

Q. Do you not know that it contemplates the diversion of the whole of the sewage from the Harlem River?

A. I do not think it contemplates quite that. It is largely diverted, but I think there are still some incoming sewers which are not included.

Q. What?

A. I think there are still some incoming sewers which are not included.

Q. What?

A. I think there are still some incoming sewers, which are not included.

Q. Do you know that?

A. I do not.

Q. Why do you testify to it, then?

A. I testified that I think so.

Q. Why do you think so if you do not base it upon your own knowledge?

A. I base it upon my general impression, and I have stated heretofore that I have not attempted to acquaint myself with the precise details of those improvements, which are recent, and are in the hands of an adequate Board and under adequate men, and I have not concerned myself with becoming acquainted with the details.

Q. If 200,000,000 gallons a day of sewage are diverted from the Brooklyn sewer and discharged off Red Hook and subjected only to the processes of screening and sedimentation, will a nuisance

1694 be created at that point?

A. Under the plan of interception and screening, I do not think there will.

Q. No local nuisance?

A. I think not.

Q. What is the plan of intercepting and screening that you have in mind, when you give that testimony?

A. The saving element there is that the sewage which is handled there is comparatively fresh sewage, and the polluting material is largely in the form of solid matter, and the screens will have the effect of removing a much larger portion of the solid matter there than if that sewage comes from a much longer distance, or at least were of much greater age; consequently, I think that the discharge of that sewage after the sedimentation and screening proposed for that will, with the manner of dispersion proposed, avoid a nuisance.

Q. What will be the age of the sewage discharged at that point?

A. That would be comparatively fresh.

Q. I am not asking you for comparisons. I am asking you if you have any knowledge or any estimate of the actual age of the sewage when discharged at that point?

A. I do not think it will be over an hour or two of age.

Q. If Mr. Allen says the age will be over six hours, you do not agree with him?

A. If Mr. Allen said that, I should pay very serious consideration to what he says, because he has probably studied it and I have not.

1095 Q. Then you are guessing, is that what you mean?

A. I would not call it guessing. I am estimating.

Q. Estimating from what?

A. From the area tributary to the sewer, and estimating the probable length of time it will require for the sewage to flow to the treatment works.

Q. What is the length of the interceptor and the longest contributing sewer?

A. I can give you the length of the interceptor which would be, I should say, about five miles in length; the longest contributing sewer I can not give you.

Q. Then, what basis have you for estimating the age of the sewage?

A. Simply a visual glance at the map, as you asked the question. I have not studied it, as I told you in detail, myself. You asked me for my opinion and I gave you the best opinion I could offhand. I think very likely that opinion will need to be enlarged. I think very likely, and I am sure Mr. Allen has given more attention to it than I have. I presume that as I gave it instantly, I should possibly want to increase that life.

Q. Well, you have testified that in your opinion there will be no nuisance created from the discharge of two hundred million gallons of sewage a day at the point in question treated by sedimentation and fine screening, for the reason that the sewage will be fresh, and not much more than an hour old?

A. I have not said that.

1096 Q. Are you prepared to stand by that opinion that there will be no nuisance created there?

A. I have not said that it would not be more than an hour old.

Q. Are you prepared to stand by your statement that there will be

no nuisance created by the discharge of 200,000,000 gallons of sewage at the point in question, provided it is submitted to sedimentation and fine screening?

A. I still hold the same opinion as I had before.

Q. Now, is it based on the same assumptions as before?

A. As to what? Presumption as to what?

Q. Of fact—presumption of fact?

A. Yes.

Q. But the sewage will not be much more than an hour old?

A. I did not say that.

Q. What did you say?

A. I said that I could only judge it to be from one to two hours of age.

Q. If that is a mistake, will you stand by your opinion that there will be no nuisance created there?

A. Why, that might be quite considerably extended in time before it would make enough difference to change my answer.

Q. What are the limits of change that you deem possible without making any change in your answer?

A. I do not understand the question.

Q. (Question repeated.)

A. Change in limits of what?

Q. Age of the sewage.

A. I should say if that were eight or ten hours old, I should have to begin to seriously consider whether that answer would suit
1097 or not.

Q. Well, assume it is eight hours old; are you able to say whether or not the sewage will be fresh or stale?

A. I would expect it to be stale.

Q. If it is stale, will it produce a nuisance if discharged at that point, after being subjected only to screening and sedimentation?

A. Let me explain that I am speaking of the age of the sewage which comes as you asked from the longest sewer. Now, that sewage would come from the longest sewer, and would differ from sewage coming from shorter sewers, and is mixed with sewage of much less age. It is not all scattered and handled and sent for six or eight or ten hours through a sewer, the oldest of it. It may be as old as you state Mr. Allen testifies, in your question; but the average age of the sewage would be very much less than that, and it is the average that will produce the conditions in the harbor.

Q. Now, then, it is not your opinion that the age of the sewage is determined by the age of the sewage discharged by the longest contributing sewer?

A. No, it is not, necessarily. The longest may also be the shortest, but in this case it is not.

Q. What does determine the age of sewage which is collected along a long line of sewer; what determines the age?

A. Something near the average length of time which the
1098 sewage is required to take in passing from its point of production to its point of discharge.

Q. Well, in this particular sewer that we are speaking of, of the

Brooklyn sewage system, which contributes to it, the interceptor is about five miles long, is it not, according to your estimate?

A. Somewhere in that vicinity.

Q. So that the age of the sewer will be determined by the length of five miles, at least, will it not?

A. Not necessarily.

Q. Not necessarily?

A. No, because some of the sewage enters that interceptor much nearer to the point of disposal than some others do.

Q. How much nearer?

A. Perhaps——

Q. Do not guess, please.

A. At least four miles nearer.

Q. So that some of the sewage enters within one mile of the disposal works?

A. Yes.

Q. Where is that?

A. That is near the point of land at South Brooklyn, extending between New York Bay proper and Gowanus Bay.

Q. If 200,000,000 gallons of sewage is diverted from Brooklyn and led to a disposal plant off Red Hook, and there screened and sedimented and discharged, by multiple submerged outlets into deep water, will that effluent so discharged, rise to the surface?

A. I think it will tend to.

1099 Q. Will it or will it not; that is a physical question.

A. I should expect it would.

Q. That is your expectation?

A. Yes.

Q. What percentage of total solids of the sewage will have been removed, in your opinion, by the works at Red Hook?

A. I can not answer that because I do not know the details of their scheme of treatment there.

Q. If subjected to sedimentation and fine screening, what percentage of total solids will have been removed?

A. I do not know what is contemplated for that treatment.

Q. Will there be a sleek field created at the point of discharge?

A. I do not think there will.

Q. Will there be a sewage created at the point of discharge?

A. I am unable to answer that question for the same reason that I have been unable to answer one or two other questions, that the detailed planning of that system is in the hands of a definite Board and I have not myself acquainted myself with the details of what they have undertaken and what they expect to do, but I have the utmost confidence in not only the technical ability, but the good judgment of the men who are preparing those plans. I do not believe they will deliberately approve plans which will produce either a sleek field or a field of sewage on the surface at that point.

Q. Will the solid matters of the sewage be finally com-

1100 minuted when it reaches the disposal plant off Red Hook?

A. I think not.

Q. Why not?

A. Because I do not think the sewage will be sufficiently old to induce that breaking-up of the solids which come from sewage of old age.

Q. How far will it have travelled?

A. Well, we have discussed that matter. I have told you just what I knew about that.

Q. Will it be pumped?

A. It will be pumped at the treatment works.

Q. Before it is sedimented and discharged?

A. Yes.

Q. Will that tend to break up the solid matter?

A. Somewhat.

Q. By any process of sedimentation and screening that you know of, what percentage of solids can be removed from the sewage, of the age of the sewage, when it reaches the proposed island off Red Hook?

A. I think it is feasible to remove 75 per cent by sedimentation and screening.

Q. 75 per cent; so that there will be 25 per cent of solids left in the effluent?

A. Yes.

Q. What processes of sedimentation and screening will remove 75 per cent of the total solids?

A. Adequate screening through fine screens, and adequate sedimentation basins, having low velocity of flow through the basins, adequate time for sedimentation.

1101 Q. In what respect will the treatment suggested by you, differ from the treatment proposed by the Passaic Valley Sewerage Commissioners, at their treatment works?

A. To what do you refer, when you say the treatment suggested by me?

Q. Adequate screening and adequate sedimentation.

A. Those statements were made in answer to your question as to what systems I knew of by which it would be possible to remove a sufficient amount to produce a removal of 75 per cent and I answered it. Those are not my suggestions. They are my answers to definite questions.

Q. Well, taking the treatment that you refer to as adequate, in what respect does it differ from the treatment proposed by the Passaic Valley Sewerage at its disposal works on the Newark Meadows?

A. Well, when I compare the two, I shall again depend on Mr. Fuller's estimate of what those works will now do, namely, that they will clearly produce the sedimentation or removal of 60 per cent. Now, starting with that as a foundation, it will be necessary to enlarge the treatment works in excess of what the Passaic Valley System now includes, so as to give finer screening, or longer and greater sedimentation, whichever is preferred to be done, or both, if necessary, to remove the additional 15 per cent.

Q. How far from the proposed disposal of the Passaic Valley Sewage at Robbins Reef is the proposed discharge off Red
1102 Hook?

A. About a mile; perhaps a mile and a quarter.

Q. The Red Hook discharge, of course, is nearer the Greater City of New York?

A. Yes.

Q. Will the discharge of 150,000,000 gallons per diem of sewage effluent from the Passaic Valley Sewerage Works on the Newark Meadows, in your judgment, create a nuisance at Robbins Reef?

A. Under what conditions of treatment?

Q. Under the proposed treatment, as you understand it?

A. What is meant by—perhaps this is covered by the stipulations or those covered by the plants as being built, or covered by Mr. Fuller as he proposes them.

Q. Those specified in the stipulation which is Complainant's Exhibit No. 134, in this cause.

A. If the sewage is treated to the extent to comply with those stipulations, there will be no nuisance there, because that is one of the terms of the stipulation.

Q. If the sewage is treated by the specific processes that are specified in that stipulation, will there be a nuisance created from a discharge of 150,000,000 gallons of effluent per diem at Robbins Reef?

A. If the sewage is treated in accordance with the stipulations, including the clause which says, "Such additional necessary features"; and if it complies with the other terms of the situation as to the occurrence of sleek fields and sewage visible particles at the point of discharge, there will be no nuisance.

1103 Q. You are familiar, I think you said, with Complainants' Exhibit No. 135?

A. Somewhat, I am.

Q. If the sewage of the Passaic Valley is treated by the processes which are enumerated under the first general paragraph of the stipulation as follows:

"(*a*) Upon the line of the trunk sewer which it is proposed shall be constructed, and at a point at or near the pumping station to be located on the Newark Meadows near the Newark Bay, it is stipulated and agreed that the sewage, waste and other matter passing through the said trunk sewer, shall first pass through coarse screens to remove therefrom all large floating matter, and after passing through such coarse screens, shall pass through a grit basin or basins, where the heavy matter shall be taken out as far as practicable, from which basin or basins the sewage and other matters shall pass through self-cleansing mechanical screens, having clear openings of over four-tenths of an inch."

"(*b*) As the sewage comes from the fine screens, it shall also pass through sedimentation basins. The sewage after passing through said grit basin and said self-cleansing mechanical screens, shall enter the sedimentation basins or settling tanks consisting of

1104 a number of units, approximately 225 feet long, and 15 feet deep. Each tank will have a normal capacity of not less than 1,250,000 gallons, making an aggregate tank capacity suf-

ficient to meet the requirements as stated herein. The tank capacity shall always be such as to provide a detention period of not less than one hour at the maximum rate of flow of the sewage, and the detention period of the daily average flow of such sewage for not less than one hour and a half. The mean linear velocities through said tanks shall not be over 0.5 inch per second for average flow, and 0.75 inch per second for the maximum flow. In addition to and in connection with these basins, scum boards shall be provided to retain the floating matter, and proper and adequate devices shall be used to remove the retained scum and deposits from the settling basins; drawings of general plan of settling tanks (sedimentation basins) as proposed at the outlet being herewith attached as Appendix A.

"(c) The sewage and waste thus screened and settled, is then to flow into a pump well, whence it is to be pumped under pressure through a tunnel at the point in the Newark Bay near Robbins Reef Light, at which point it is agreed that the matter passing through the said tunnel shall be dispersed into the waters of New York Bay through a series of outlets discharging 40 feet or more beneath the surface of the water at mean low tide. From the end of the tunnel connections shall be made with four or more
1105 discharge pipes extending across the current, spaced about 100 feet apart, laid in trenches on the bottom of the Bay, and to a size decreasing in diameter from about 6 feet to 2 feet. On top of these discharge pipes will be a series of not less than 150 tees, of a diameter not exceeding one foot, and spaced approximately ten feet apart. On each of these vertical tees shall be placed outlets arranged to discharge horizontally across the tidal currents, and the extent of the dispersion area for this system of outlet pipes, shall cover at least 3.5 acres at the bottom of the Bay"——

Now, if an effluent of 150,000,000 gallons a day from the works thus described shall be discharged at or near Robbins Reef, in your judgment will a local nuisance be created?

A. I can only say that in my opinion the effluent discharged from the works as you have described it, will not produce the results which are predicated in Section second.

Q. I did not ask you that, Professor. I asked you whether, in your judgment, a local nuisance would be created at the point of discharge?

A. I think objectionable conditions will be produced there; whether they would reach a severity to be called a nuisance or not, I should hardly like to say.

Q. Will there be a sleek field established there?

A. I hardly think so.

1106 Q. Will there be a sewage field established there?

A. I hardly think so.

Q. If the effluent is increased to 200,000,000 gallons a day, will there be a sewage field established at that point?

A. I think it would begin to be very appreciable then——

Q. Would there be a sleek field?

A. I am speaking now of the effluent from the Passaic Valley trunk sewer, the Passaic Valley trunk sewer disposal.

Q. Yes. That is the effluent I am asking you about; whether, in your judgment, an affluent of 200,000,000 gallons a day, from the works as described in the part of the stipulation which I have read to you—I am asking you whether there will be a sewage field established there.

A. I think sewage would be visible there.

Q. I am asking you whether there would be a sewage field established there?

A. Just what is meant by a sewage field?

Q. You do not know what a sewage field means?

A. A field where you dump sewage.

Q. When you said there would not be a sewage field established by the discharge of 150,000,000 gallons a day, what did you mean?

A. I assume you mean the present visible particles of sewage in sufficient number to be obnoxious.

Q. You have answered the question, however, that you do not think there would be a sewage field established. Now, what
1107 was it that you did not think would be established?

A. I do not think there would be sufficient aggregation of sewage together to constitute what I assume you meant then as a sewage field.

Q. But if you add 50,000,000 gallons a day to the 150,000,000, in your judgment there will be such a sewage field established; is that your meaning?

A. I hesitated in my answer, because I thought it was on the verge of the production of the relations that you ask about; namely, a nuisance, or a sewage field or a sleek field.

Q. But you have stated positively that you do not think the discharge of the effluent of 200,000,000 gallons a day from the Red Hook plant would not establish a sewage field or a sleek field?

A. Yes, I did.

Q. Why did you distinguish between the two?

A. Because there is a very distinct difference between the two sewages. The Brooklyn sewage is comparatively a young sewage. It has not been putrefied for the length of time that the Passaic Valley sewage has. The Passaic Valley sewage comes to the trunk sewer through flat graded sewers, which must, of necessity, have a low velocity. Some of these are large sewers, and represent a long flow. After it reached the trunk sewer, it then has a good many miles of flow before it, and it is consequently at least twice the age, a good deal more than that, of the Brooklyn sewage, when
1108 it reaches the point of discharge. Moreover, according to the stipulations which you have read, and which are totally in variance with the plants being built, the sewage is screened before it is pumped, and therefore it is screened before it gets the breaking-up influence of the dumps. By the plant as being built, the pumps come before the sedimentation takes place and there is no screening, except that which the coarse bar screens produce.

Q. Those are the reasons?

A. Those are the reasons.

Q. What is the age of the sewage? What has the age of the sewage to do with the establishment of a sleek field?

A. The decomposition of the sewage tends to liberate the grease from the sewage. It tends to break up solids, tends to separate particles. It is the progressive decomposition that is peculiarly active in breaking up solids into smaller particles, and that breaking-up tends to separate the grease and globules, so that it is far more likely that a sleek field will occur from old sewage than from new sewage.

Q. What has the age of the sewage got to do with the establishment of a sewage field?

A. The age has less to do with it, but when you ask about the occurrence of a sleek field, you connect it with the Passaic Valley sewer as it is stipulated to be built and not as it is being built. It is stipulated to be built by screens having four-tenths of an inch clear opening for the finest screens, even they are not being
1109 supplied in the plant as being built; but the stipulations themselves only demand openings as fine as .4 of an inch; whereas, the openings of the screens that are proposed through the New York sewers, are very much finer than that, and every time you reduce the dimension of a screen opening, you increase very rapidly the quantity of solids which are being removed by the screen. Now, more especially if that sewer is young and is not yet at an age adequate to break it up into particles too small to pass that screen, you will catch a larger proportion of them; that is the reason I am making a difference between these two sewage outlets.

Q. Read the question that I asked.

(Question repeated as follows: "What has the age of the sewage got to do with the establishment of a sewage field"?)

A. I answered that also.

Q. You have answered it also?

A. Read the answer.

(Answer repeated as recorded.)

Q. I do not want you to read the answer; I want you to answer it again,—"What has the age of the sewage got to do with the establishment of a sewage field?"

A. I have already said in my former answer that it had less to do with the sewage field than with the sleek or grease.

Q. What is the element which causes the establishment of a sewage field?

A. The escape of particles of sewage sufficiently large so
1110 that they are visible to the eye in themselves, and also large enough to form a more or less permanent center of bacterial putrefactive operation, and thus form scum and bubbles surrounding the particles. That explained what I understood you to mean when you speak of a sewage field—the presence of visible particles of sewage in sufficient number and frequency and size to be clearly visible to the eye.

Q. On the surface of the water?

A. Yes, sir; you can not see into the water very well.

Q. Is it not, then, a question of the existence of solids having a lesser specific gravity than the water into which they are discharged; is that the element which determines the creation of a sewage field?

A. Of the solids in the aggregate, including the bubbles of gas which form by decomposition, they must be lighter than water in order to float.

Q. What effect has the age of the sewage upon the creation of such a sewage field?

A. The age of the sewage will tend to advance the degree of putrefactive decomposition, and tend to buoy up more particles of sewage than would be the case from younger sewage.

Q. Will the age of the sewage have a tendency to break up the sewage solids into smaller particles?

A. Yes.

Q. And make them less visible to the eye?

A. If that breaking up goes on to a sufficient extent, yes.

1111 Q. Now, why do you say that the discharge of an effluent from the works, as described in the stipulation between the United States of America and the Passaic Valley Sewage Commissioners, amounting to 200,000,000 gallons a day, will create a sleek field, and a sewage field, and a nuisance, whereas 150,000,000 gallons a day will not create them?

A. I thought I had explained that difference once.

Q. Well, explain it again; how do you fix on 50,000,000 gallons a day as being the amount which will result in the objectionable features?

A. I have already explained that even the smaller amount would be, in my opinion, in the zone of doubtful result. It may be that I was wrong, and that a distinct sleek field will occur for 150,000,000 gallons, and a distinct sewage field will occur; but I hardly think so. When you add, however, an amount of sewage to that, then it puts it where I can speak a little more definitely about it. I think there will be no doubt.

Q. Has the fact that the proposed discharge from the New York works of 200,000,000 gallons a day, anything to do with influencing your conclusion?

A. As to what?

Q. As to whether a nuisance will be created by the discharge of the effluent?

A. Effluent from which?

Q. From the Passaic Valley sewer?

A. No.

Q. Nothing to do with it?

A. Certainly not.

1112 Q. That is only a coincidence, is it not?

A. Do you mean whether my answer is influenced by the fact that I know there is to be a point of effluent there, then I say it has nothing whatever to do with it—assuming the water to be in the same condition; but I do not wish to deny this fact, that one sewer discharging into a bay or pool or arm of the harbor, might not make a nuisance, or the other alone might not make a nuisance; but

the two together might make a nuisance. Now, in that, I have reference to this fact: That the capacity of the harbor waters to dispose of its sewage harmlessly, and in an unobnoxious manner depends largely on its oxygen content for rapidly oxydizing the organic compounds which have been produced, which are oxydizable, and also for preventing anaerobic putrefactive decomposition from taking place. Now, if that supply is already partly absorbed or depleted, by any source, it does not matter which State it comes from, the likelihood that a nuisance will be created by some other discharge will be increased.

Q. I wanted you, if you would, to determine from your testimony, how you reach the conclusion that a discharge of 200,000,000 gallons of effluent from New York works will not produce a nuisance, while the discharge of 200,000,000 gallons of effluent from the New Jersey Passaic Valley Sewage Works will produce a nuisance?

1113 A. Well, I have explained that once and I will explain again briefly, that the sewage is far less favorable to make a nuisance; and secondly, the screens are finer than .4 of an inch.

Q. How do you know?

A. Because I know that no screens are being considered of a degree as coarse as .4 of an inch.

Q. What is the distinction between organic matter and putrescible matter, so far as sewage is concerned?

A. Most organic matter is putrescible, but not all of it, or rather, I should say that there is quite a range of difference in the rate at which different kinds of organic matter will putrefy. Some will putrefy only slowly, others rapidly, and while it is all organic and all ultimately subject to decomposition, the difference in the rate of decomposition will make one kind of sewage—what we speak of as putrescible matter, and another kind of sewage or organic matter—what we speak of as non-putrescible matter. It really is not non-putrescible, but its putrefaction takes place at so slow a rate that the products are harmlessly disposed of and dissolved; while in the other case, the rate of putrefaction is so great that the products are given off faster than the water can absorb them, and an unobjectionable condition is produced.

Q. Where did you find that distinction?

A. I do not know where I did. It is a matter of common knowledge among chemists and sanitary engineers. I can not trace

1114 just my source of information of it.

Q. Has it any authority in the lexicons, the dictionaries?

A. I presume it has.

Q. Have you looked to see?

A. No.

Q. You testified on your direct-examination that the State and City of New York had been taking steps to reduce the harbor pollution coming from New York. Now, what are those active steps which you state the City of New York has taken to reduce the pollution coming from New York?

A. In the first place, very extensive and deliberate and thorough investigations of existing conditions, which was the first thing to be

done in any large undertaking of this sort; and, in the second place, the preparation of tentative plans. In the third place, the adoption of some of those tentative plans; in the fourth place, the laying out of a definite program to make possible the very extensive expansion of those plans in the near future. In the next place, the actual construction of some of the plans into the form of works.

Q. When did this work begin?

A. It began in an organized systematic way with the formation of the Metropolitan Sewerage Commission, or more properly with the formation of the New York Bay Pollution Commission.

Q. In 1902?

A. In 1902.

Q. That is 17 years ago?

A. Yes.

1115 Q. And you have characterized the action as active have you?

A. I have characterized that as active.

Q. Now, what works have actually been built?

A. Have actually been built?

Q. Yes.

A. The Dyckman Street works.

Q. What else?

A. Work has been commenced on a number of other projects. I can not tell you just now which they are.

Q. Do you know that of your own knowledge, that any contracts have been let for any other plants?

A. I do not know that contracts have been let.

Q. Would work have been done, if you know, on any other plants than the Dyckman Street plant?

A. I have not acquainted myself with the details of the recent execution.

Q. Do you know how much the Dyckman Street plant has cost?

A. I do not.

Q. $42,000; does not that refresh your memory, or have you no memory on the subject?

A. I do not know whether I have ascertained at all the cost of it.

Q. Do you not know that it has cost considerably less than $100,000?

A. No, I do not.

Q. You do not know anything about it?

A. No.

Q. Why do you call what has been done the adoption and taking of active steps to reduce the harbor pollution?

A. I did not confine my statement as to what has actually been done in the form of active steps, to that which has actually

1116 been let by contract; but the more serious and by far the more important part has been done, and other portions of that which are highly important are being done, some of the most effective work that is going on counts towards the ultimate purification of New York Harbor, which is now being done, but it is not under contract yet; yet, it is now being done.

Q. What reason, Prof. Landreth, is there, why these individual plants along the Manhattan shore of the Hudson River, have not been built; is there any reason?

A. The inevitable time required in getting approval and appropriation of funds, and the letting of contracts.

Q. Do you know whether or not the plans were presented and adopted in 1915?

A. Some were.

Q. Do you think it is active work not to have taken any further proceedings on these plans adopted up to the present time?

A. I should not have called it active if there had not been very good reason for the delay.

Q. Yes; what reason?

A. Primarily, the difficulties in securing funds.

Q. During this period, has the great aqueduct been in course of construction for the City of New York?

A. During that time it has been in course of completion.

Q. How much did that cost?

A. It cost a good many million dollars.

1117 Q. Over one hundred million?

A. I think so.

Q. Over one hundred and fifty millions?

A. Yes; possibly one hundred and sixty, I think.

Q. And the Dyckman Street plant, so far as you know,—you do not know anything about the cost of it?

A. I know that whatever it cost, it has been instituted as a contract work very recently, and long years after the Catskill System was inaugurated and commenced. After the Catskill System was organized and commenced, it was good, municipal policy to go on and complete it and get the benefit from it; and as rapidly as that is completed, and the expenses of that stopped and that comes to be a revenue-producing agency in the City System, it will aid in making funds available for other important purposes.

Q. During the years from 1915 to the present time, have there been subways built in the City of New York by the City of New York?

A. Not instituted since that time.

Q. Constructed?

A. Not originated since that time. Some have been completed since that time.

Q. How much do they cost, do you know?

A. I do not remember now.

Q. Many millions of dollars, have they not?

A. Yes.

Q. One hundred millions?

A. Yes.

Q. More than that?

A. Yes.

1118 Q. The City has been able to get that money, has it not?

A. It was obliged to carry on the work which had already been instituted, which is very different from carrying on a piece of work which is well planned, and requires the expenditure of money

year by year. It is very different. The necessity for keeping up the supply of funds in order to complete it and make the system of use to the public, is a matter of urgency, and would, in most cases, prevent a well-advised municipality from embarking on other things, and stopping these things which are partially and nearly complete.

Q. Those things being more necessary, in your judgment, than the matter of sewage disposal.

A. No, I do not think they are more necessary, but I think they are already inaugurated. They already represent an expenditure of large amounts of money, which would be of no use until they are finished.

Q. They have been inaugurated since 1902, these building works?

A. Some of them have, yes.

Q. All of them?

A. No.

Q. Not the Aqueduct?

A. I beg your pardon?

Q. Not the Aqueduct? Was not that inaugurated since 1902; that is, 17 years ago, Professor?

A. At first I supposed you referred to the subways.

Q. No; I asked you whether the Aqueduct was inaugurated since 1902?

1119

A. No. The Aqueduct surveys were, I think, pretty well complete, and I am not sure whether the contract had been let or not, possibly not, at that time but the urgency of New York for an additional supply of water, was on the City, and it had already executed its careful investigations for the Aqueduct. It had made its surveys, its plans, and I am not sure whether at that time it had entered into any contracts or not. The undertaking had been inaugurated, that is clearly the case, and before 1902.

Q. You have testified that the excuse and reason you have given for the inactive progress for the actual construction of a sewage disposal plant of the City of New York, was the lack of money; did you testify so?

A. I did.

Q. Do you know whether there is any more difficulty in getting money for this project, than for subways and aqueduct purposes?

A. I do not know that there is.

Q. So that you are still prepared to say that in your judgment, the steps taken by the City of New York have been active for the removal of the pollution of the waters of New York Bay and its tributaries from the sewage in New York?

A. I do.

Q. Are you a lawyer?

A. No.

Q. Did you have any legal instruction at all?

A. None, except my reading in law which has been done privately.

Q. You have undertaken to formulate two separate forms

1120

of decree in this litigation, have you not, Professor?

A. No.

Q. What was it that you were reciting yesterday afternoon, or

rather reading from—a prepared pamphlet in the way of recommendations?

A. Two separate sets of recommendations which might be incorporated either into stipulations, or into a decree. I did not attempt to prepare the decree.

Q. Now, turning to recommendation A, will you get your pamphlet which you had in your prepared testimony, and consult it, please.

A. Certainly. (Perusing paper.)

Q. What does recommendation A comprehend?

A. It contemplates the abandonment of all further construction and use of that portion of the outfall and tunnel sewer which lies under the waters of New York Bay, and all portions of the discharging and dispersion systems under the waters of New York Bay——

Q. Will you pause there a moment for a question. This work is within the territory of the State of New Jersey, is it not?

A. Yes.

Q. If the State of New Jersey sees fit to build a tunnel in its own territory, you recommend that it be compelled to discontinue it, do you?

A. For this purpose, yes.

Q. For what purpose?

A. For the purpose of discharging sewage into New York
1121 Bay.

Q. Yes; but you propose to compel them to discontinue the construction of it?

A. Yes.

Q. Within its own territory

A. Yes.

Q. Go on.

A. And the permanent abandonment of the proposed discharge of effluent, or sewage from the proposed Passaic Valley stream into any part of New York Bay. It contemplates, however, the discharge of the effluent or sewage from the detention basins, as they may need to be modified, into any part of Newark Bay or into streams entering Newark Bay, as the defendants may choose at any point on or up-stream from, the line where the effluent tunnel from the sedimentation basins to Robbins Reef crosses under the waters of Newark Bay. This discharge into Newark Bay is, of course, to be subject to whatever regulations the Secretary of War may impose as a condition of such discharge, and should also be subject to a condition imposed as an element of protection to the waters of New York Bay, of Kill Van Kull and of Arthur Kill, namely that the effluent or sewage discharge from the proposed system into Newark Bay shall, before being discharged, be not less thoroughly and extensively purified than would have been necessary to meet, fully and unquestionably, the requirements of the existing stipulations made between the United States and the Passaic Valley Sewerage
Commissioners, dated April 14th, 1910, and in evidence in
1122 the present case as Complainants' Exhibit No. 135, and as Defendants' Exhibits 6 and 7.

Q. Now, pause there while I make an inquiry as to that. Why do you select the point of discharge of effluent in question, at a point on or about the line of crossing in Newark Bay, by the outfall portions only?

A. As another means of protection to the waters of New York Bay, namely, that the point of discharge shall be sufficiently removed from the nearest waters of New York Bay or the Kill Van Kull or Arthur Kill, as to be clearly free from the danger of injuriously affecting those waters.

Q. Professor, have you not said that an effluent which complies with the stipulation, and which you now impose upon the effluent to be discharged into Newark Bay, can be safely discharged anywhere?

A. No. I have not said that.

Q. When you refer to the stipulation, do you refer to the whole of the stipulation?

A. When I denied having said it, I referred to my answer which had been confined by you to Section No. 1, and not including Section No. 2.

Q. I am asking you when you impose from the effluent which you would permit in recommendation A to be discharged into Newark Bay, the stipulation which is Complainants' Exhibit No. 135, do you mean all of that stipulation?

A. I mean all of it.

1123 Q. Now, an effluent which conforms to all of that stipulation can be safely discharged anywhere, can it not?

A. I do not think so.

Q. What is the reason?

A. I did not say so.

Q. What is the reason it can not?

A. I have not said so in the first place.

Q. Well, give it.

A. I do not think so, no.

Q. Why not?

A. Because it might with the size of screens which are permitted in that, still be very decidedly objectionable, the size of screens and the extent of sedimentation.

Q. I will read you of the second general paragraph, sub-title 5, "There will be no injury to the public health which will be occasioned by the discharge from the said sewer into the Bay of New York in the manner proposed, and no public or private nuisance will be created thereby." Do you propose to impose that upon the effluent which you suggest under recommendation A may be discharged in a definite part of Newark Bay?

A. I have very grave doubts as to whether that sub-section 5 would be of very much protection because of the additional clause which is added to it: "From the said sewer into the Bay of New York." It might be never so harmful and serious, and still it would be perhaps a difficult matter to identify the harm which came from

1124 this particular one. Grounds might be alleged that some other sewer, perhaps a mile away, was the real cause or the modifying cause; so that I said that that clause as it is writ-

ten, in my opinion is worth little as an element of protection.

Q. For an effluent to be discharged under the stipulation in Complainants' Exhibit No. 135, into Newark Bay, and to conform to it, what would be necessary, in your judgment?

A. I just expressed that judgment in the form of my recommendations, that these same stipulations be imposed on it.

Q. The stipulations then will be: "There will be an absence in New York Bay of feasible suspended particles coming from the suspended Valley sewage"; is that something that is to be imposed upon it when discharged into Newark Bay?

A. That is a modification, and while it would not have been originally written there, would still remain. As a matter of recognizing the difficulty of getting a legal stipulation changed or modified, I should still let that remain there, even though I should not have framed those words, if it had been planned to discharge it at first into Newark Bay. I should let this stand there.

Q. You substitute Newark for New York in this change, do you?

A. No, I do not make any change whatever; I try to avoid that.

Q. You do try to make no change at all, and it being assumed rather that the effluent is to be discharged in a definite part
1125 of Newark Bay, the guarantees will be of the results in Newark Bay, that is what you recommend, is it?

A. I recommend that the stipulation be left just as it is.

Q. Yes.

A. Primarily on account of the difficulty of getting the stipulations modified, and the time it requires and the seriousness of the questions of risks involved in doing it.

Q. What I want to know from you is how you can apply this stipulation into a discharge into Newark Bay.

A. If it is workable under the proposed plan to discharge at Robbins Reef, it certainly would be much easier for you to discharge it into the upper end of Newark Bay.

Q. It does not answer the question. I want to know your suggestion or recommendation so as to make the stipulation applicable to an effluent discharged into Newark Bay.

A. My recommendation is to leave it just as it is.

Q. Then, so far as the second paragraph is concerned, you would leave it as it is, as follows: "Second. The Passaic Valley Sewerage Commissioners further agree with the United States that in the operation of the said sewer system at all times the following results shall be secured, either through compliance with the requirements of the immediately preceding paragraph, or through requisite lawful additional arrangements, namely: 1. There will be absence in the New York Bay of visible suspended particles coming
1126 from the Passaic Valley Sewage."

A. I would leave that just as it is.

Q. Does it make any difference in your judgment where and in what part of Newark Bay the effluent is discharged, so far as that result is concerned?

A. I think if it is discharged above the line I have indicated, there

would be no danger to New York Bay from these points, if you carry out the whole of the stipulation.

Q. "That there will be absence of deposits objectionable to the Secretary of War of the United States in the New York Bay coming from the Passaic Valley sewage."

A. I would leave that just as it is.

Q. You would have, in other words, a stipulation which, in its express terms refers to a discharge in New York Bay, applicable to a discharge in Newark Bay, and a certain limited part of it, would you?

A. I would. I would leave it just as it is, even though it is inappropriately worded. I have already stated some reasons for not changing it. In the first place, we need protection which distance will give; in the second place it will be very difficult and uncertain to provide a change in the wording of those stipulations.

Q. You propose a new stipulation, do you not, Professor?

A. I propose a new stipulation covering totally different things from this.

1127 Q. Any difficulty in re-framing these stipulations to conform to the new conditions?

A. If the State of New Jersey showed any inclination to co-operate with the State of New York on a reasonable basis, as New York has constantly endeavored to have accomplished, then I think there would be no difficulty in the two states reaching a conclusion as to a new form of stipulation which might wipe off this one and substitute another in its place.

Q. But your recommendation is for a decree which will incorporate the features which you name, or will require a stipulation to be entered into?

A. In a decree, if a stipulation can not be reached by mutual agreement between the two parties, but in the absence of that—and our experience with our efforts to secure co-operation from New Jersey has not given us very good reason to expect very much in that direction—in the absence of that willingness to agree, I recommend that this be incorporated into a decree of the Court.

Q. Now, what sort of effluent, in your judgment, will it be necessary to produce, in order to accomplish the stipulated guarantees of the second general paragraph of the stipulation, Complainants' Exhibit No. 135, when discharged within the limits recommended by you in Newark Bay?

1128 A. I have already several times stated that I think it would be entirely safe to leave them in the present form just as they are.

Q. Just as they are; that is, an effluent produced by works described in the first general section of the stipulation?

A. Yes, and complying with the requirements of the second. If the first are not adequate, then the second makes it obligatory to expand the requirements imposed in the first until they are adequate.

Q. Now, can you determine whether an effluent produced under the first general section of the stipulation accomplishes the result in New York Bay, which are comprised in the second general section of the stipulation?

A. The parties to the stipulation evidently expected that it would be possible to determine that by the test proposed under Section 2, numbers 1 to 6 or 1 to 7.

Q. Yes; but you, I think, have said that you can not determine it because of the possible effect of other polluting agencies which would render the performance of the second section of the stipulation impossible of determination.

A. Well, I said it would furnish ground for an alleged claim that the probable cause, no matter where it arose, might be due to some other polluting agency.

Q. What sort of an effluent or discharge is now being made into that section in Newark Bay, within which you say that the effluent should be discharged under a stipulation or by decree of the
1129 Court? There is an effluent being discharged there now, is there not?

A. The district or territory in which the discharge is not prohibitive includes the upper portion of Newark Bay and streams entering therein. Now, there are many effluents of sewers entering in that territory and that district.

Q. Is not the sewage the matter that is in the Passaic River, an effluent when discharged into Newark Bay?

A. Most of it is not discharged into Newark Bay. Most of it is partially reduced in the streams themselves, and that partially reduced effluent has been sufficiently treated in the streams themselves, so that in Newark Bay it does not now produce a nuisance, and is adequately disposed of.

Q. It has not been subjected to any treatment at all, except lying in the Passaic River, has it?

A. No, that is all.

Q. And is discharged into Newark Bay in a highly septic condition, the decanted effluent from that is discharged into Newark Bay and there it is adequately treated by the present natural causes, so that the natural causes are adequate to dispose of a non-treated sewage mass, when discharged from the Passaic River.

A. Not untreated—treated exactly as this calls for here. I say not less.

Q. But I am talking of the present conditions; I am asking you about the present conditions, Professor; the sewage that is carried by the Passaic River is discharged into Newark Bay, is it not?
1130 A. Only a portion of it, the decanted liquid portion, after the solids have settled, is discharged into Newark Bay. The highly objectionable portion, however, has been deposited and remains in the Passaic River.

Q. You are quite sure of that, are you?

A. Yes.

Q. Do you not know that there is sewage deposits in the form of sludge in the bottom of Newark Bay?

A. Yes.

Q. Where does it come from?

A. It comes from the tributary sewers.

Q. The tributary sewers?

A. The sewers from the municipalities on the banks.
Q. What municipalities on the banks?
A. Newark, for example, and Passaic.
Q. Passaic, on the banks of Newark Bay?
A. I am speaking now of the Passaic River. You spoke of the Passaic River.
Q. No, I am talking about Newark Bay; I asked you whether there are not sludge deposits on the bottom of Newark Bay?
A. I presume there are, but——
Q. Don't you know there are?
A. I should presume there are. That is far as I can go.
Q. I ask you whether you do not know there are?
A. I never made borings myself there. I am not sure whether our Commission made some borings up there or not, but I
1131 should expect to find deposits of sewage in Newark Bay.
Q. Where do they come from?
A. But the fact remains that the deposits are not sufficiently extensive and objectionable to form a nuisance in Newark Bay.
Q. Where do they come from, in your opinion?
A. Undoubtedly they were those that were washed in from the tributary streams.
Q. The Passaic River?
A. Among those largely, yes.
Q. Then it was not the sewage discharged into Newark Bay; it is not completely decanted in your opinion?
A. Primarily and mainly decanted, and I only admit that there possibly may be deposits in Newark Bay. I do not know that there are. If you wait a moment, I will see if we ever made any borings into the mud at that point. I can not answer that definitely. I should not be surprised to find some deposits there, but I am only depending on this fact from my own observation, that the waters of Newark Bay lying over those deposits, if there are any deposits there, are in a reasonable state of purification, and a reasonable state to handle additional sewage.
Q. Yes; and the decanted sewage discharged into Newark Bay from the Passaic River, is it entirely devoid of oxygen or not?
A. I presume the sewage thus taken, apart from its diluting water, is devoid of oxygen.
1132 Q. Now, you are going to impose the terms of the stipulation upon this discharge of effluent into Newark Bay within the limits that you have described, in the terms in which it is written. Will you tell me how you are going to determine whether or not there is absence in New York Bay of visible suspended particles coming from the Passaic Valley sewage?
A. That determination would be far less than the difficulty of determining it, proposed to be discharged at Robbins Reef.
Q. It would be far less?
A. Far less.
Q. Why?
A. Because it would not be mixed with sewage from any other locality. That from Newark Bay, in New York Bay might be

mixed. The particles might be alleged to come from other sources.

Q. How will the effluent discharged into the upper part of Newark Bay reach New York Bay?

A. By the gradual fresh water discharge from Newark Bay partially into New York Bay, and partially through Arthur Kill and by the swinging of the tide back and forth, and some of the tide on ebb passed out through Kill Van Kull. The major part goes through Arthur Kill, and some part would reach New York Bay through Kill Van Kull.

Q. And as it passed out through Newark Bay and the Kill Van Kull and Arthur Kill, what municipalities and settlements does it pass?

A. If it passes through the Kill Van Kull it passes be-
1133 tween the municipalities of Bayonne on one side and Richmond Borough on the other.

Q. Does it pass Elizabethport, part of Elizabeth?

A. That which comes up through Arthur Kill.

Q. Does not that part which comes out from the Kill Van Kull pass Elizabeth—Elizabethport?

A. I do not remember just how far the boundary of Elizabethport extends up——

Q. Do those municipalities sewer the waters that you have named?

A. I judge they do.

Q. How can you determine whether sewage particles in New York Bay have come from the Passaic Valley sewage effluent discharged into the upper part of that Bay, or from Elizabeth or Bayonne, or the municipalities of Staten Island?

A. Because at the point of discharge there are no other municipalities discharging there.

Q. Then you are going to modify this stipulation, and have it that there will be an absence in Newark Bay of particles coming from the Passaic Valley sewage?

A. It is possible to trace their path from the place where they are discharged now to New York Bay.

Q. It is possible to trace them down to New York Bay and identify them in New York Bay, is it?

A. Trace the flow, yes.

Q. You will be able to say whether or not suspended particles which are visible in New York Bay, come from the Passaic
1134 Valley Sewage effluent discharged in the upper part of New York Bay?

A. If you are half as anxious as——

Q. Won't you answer the question?

A. Yes, I will answer it.

Q. Answer it.

A. I would say if you are half as anxious to reach an agreeable solution with New York as you are to pick flaws or raise difficulties in my testimony just as it is, then we should avoid all this difficulty altogether. I admit there is difficulty there of identification in each case, but I say it is no worse, and in my opinion it is bet-

ter and less difficult to discharge into Newark Bay than it is now into New York Bay.

Q. You say that it will be less difficult to determine in New York Bay the results of a discharge of an effluent in Newark Bay than it would be if that same effluent were discharged directly into New York Bay; is that what you mean to say?

A. I do.

Q. You heard the testimony, I think, of witnesses, that there will be a sleek field and a sewage field and a local nuisance created at the point of discharge of the Newark sewer in the New Jersey sewerage system into New York Bay; do you agree with that?

A. I have testified that I thought it was just on the verge of producing such a nuisance, and I still think so.

Q. Will there by any difficulty in determining that that
1135 was produced by the New Jersey sewage?

A. There will be no difficulty in reality, but difficulties might be alleged and offered to comply with the strict terms.

Q. In what way, if effluent is discharged into the upper Newark Bay, will there be deposits objectionable to the Secretary of War in New York Bay?

A. I presume there would not.

Q. If the effluent is produced and discharged into Newark Bay at the point within the limits indicated by you, will there be any odors produced in New York Bay, due to putrefaction of organic matters contained in the Passaic Valley sewage?

A. I think not.

Q. Will there be an absence on the surface of New York Bay of any grease or color due to the discharge of the Passaic Valley sewerage, due to the dispersion?

A. I think not, using the word "dispersion"—what are you referring to when you speak of dispersion, now?

Q. I am talking about a dispersionary effluent, which is discharged into Upper Newark Bay?

A. I do not think there will be any deposits objectionable to the Secretary of War, if you are referring to Section 2—Section 2.

Q. I am asking now about odors.

A. I do not think there will be any difficulty in New York Bay from odors produced at the dispersion area in Newark Bay.

Q. Will there be any grease or color on the surface of
1136 New York Bay if the effluent is discharged in the upper reaches of Newark Bay?

A. I should not expect so.

Q. Will there be any injury to the public health occasioned by the discharge of the sewage from said sewer into the upper reaches of Newark Bay?

A. The public health in New York?

Q. Yes.

A. Or in the vicinity——

Q. Public health, you are interested in in New York, are you not?

A. Yes.

Q. Public Health in New York?
A. You did not state.
Q. Public Health in New York?
A. I do not think there will be any impairment.
Q. Any public or private nuisance created within the limits of New York State in the discharge of the effluent in the upper reaches of Newark Bay?
A. Not if the full stipulation is carried out.
Q. Will there be any injurious effect upon the property of the United States in the harbor of New York?
A. Not if the full stipulation is carried out.
Q. What do you mean by that?
A. I mean that if you carry out all the terms of this stipulation, beginning with Section 1 and going through the whole of them, there will be no injury to the United States property.

Q. That is to say, if there is no injury, there will be no
1137 injury, that is what you mean?

A. Yes.

Q. Well, I have asked you if the effluent as discharged into the upper reaches of Newark Bay will be of any injury, in your judgment, to the property of the United States?
A. I have answered it already. My answer was directed to just that question.
Q. And if that effluent is discharged as you propose, in the upper reaches of Newark Bay, will there be a reduction of the dissolved oxygen contents in the water of New York Bay, to such an extent as to interfere with fish life?
A. I think not.
Q. Then why do you impose the whole stipulation upon the effluent to be discharged into the upper reaches of Newark Bay, if the mere discharge there will not result in the violation of any of the guaranteed features?
A. Because I have admitted that these harmless results would follow because of the distance of removal.
Q. But all that you really insist upon in your recommendation is that there shall be an effluent produced by the same character of treatment as is disclosed by the first section of the stipulation?
A. No, I have not stated that at all, and I do not admit it.
Q. What do you mean, then?
A. I mean just what I say in my conditions. They are plainly written, and if any part is doubtful, I would be glad to read it and try to explain it.

1138 Q. Now, Professor, what conditions do you impose upon New York for the discharge of its sewage into New York Bay or tributary waters, as a condition for the imposing of the requirements on New Jersey?

A. I can not speak for the State of New York, but I assume that New York would occupy the position it has always occupied—it is ready to co-operate with New Jersey. It started in at the very beginning to make a proposal by its legislature in 1902, to help New

Jersey in the settlement of this difficult problem, and its efforts in this direction were rejected.

By Mr. McCarter: Counsel for the State of New Jersey would like to know what he means by that remark, and what there is of record anywhere to show it.

The Witness: I mean this, Mr. McCarter, that the Act creating the first New York organization, namely, the New York Bay Pollution Commission, was formulated with the express purpose of meeting this situation, and in the duties imposed, there were stated there should be an effort made to co-operate with the authorities of New Jersey to meet this situation together, conjointly; and we did submit, if you will recall, an opinion of our own Attorney General, as to our powers to the extent of which appears in that direction, and they were entirely adequate; and at a formal meeting with the Passaic Valley Sewerage Commission, or with one of the New Jersey Commissions, having the matter in hand, a joint meeting
1139 with them, in their rooms in New Jersey with our New York Bay Pollution Commission members, this matter was definitely proposed and was rejected, and that proposal has been extended repeatedly, even after this litigation was instituted.

By Mr. McCarter:

Q. What was?

A. And testimony was being taken. We made the suggestion that possibly we might write a stipulation that New Jersey, that is, between New York and New Jersey, on somewhat the same lines of effort which had been reached—tentatively then between the United States Government and New Jersey, by which we also might withdraw from the suit, and that was rejected.

Q. With whom were those negotiations conducted, so far as the State of New Jersey is concerned?

A. Through delegates from the State of New Jersey.

Q. Who?

A. Mr. Fuller was one; Mr. Edlow Harrison was another, and I do not remember who was the third.

The Commissioner: Gentlemen, the hour for recess has arrived.

(Recess to two p. m.)

1140 Prof. LANDRETH, resumed.

By Mr. McCarter:

Q. Have you been able to think of the other person who was present at this interview?

A. Do you mean at the interview——

Q. At which you said Mr. Harrison and Mr. Fuller were present.

A. I have not. It may have been Mr. Taylor, but I hardly think it was.

Q. The Mr. Harrison and the Mr. Fuller you refer to, were both engineers of the Passaic Valley Sewerage Commission, were they not?

A. Mr. Harrison was at that time. I do not know whether Mr. Fuller had been engaged until he was called in for that purpose—for the purpose of that interview.

Q. The point I am directing your attention to is the question whether or not any accredited representative of New Jersey, as distinct from the Passaic Valley Sewerage Commission, ever was appealed to or attended a meeting?

A. My impression is, though the record will show the true condition of affairs—my impression is that at the first interview between the delegates from the two States the representatives of New York met the representatives of the Passaic Valley Sewerage Commission, and I also think representatives of the State Board of Health, which at that time did have some over-lapping or conflicting juris-
1141 diction. There was some doubt or some uncertain feeling as to the authority at that time, and it is my impression that the State Board of Health of New Jersey was represented, although I am not sure of that. I have my testimony in the original papers in these cases, which was made after having examined the record, and it indicates just who were present, and just what body was represented.

By Mr. Riker:

Q. Was this interview after the testimony was taken in this case?

A. No, I am referring now, in answer to Mr. McCarter's question, to the first interview had between our New York representatives with the Passaic Valley Sewerage Commission, which was held in Jersey. There was another interview which I referred to which was held in New York here between the representatives of the two states, after this litigation commenced, and that is the one at which Mr. Fuller and Mr. Harrison were present from New Jersey.

Q. The latter one, after the testimony began, that is the one at which they were present?

A. Yes.

Q. Now, your recommendations A and B, were designed to embody matters that would go into a decree in this cause, if they were not stipulated, is not that so?

A. That was my suggestion that they should primarily go into the stipulation, if not, then into a decree.

1142 Q. In the present suit in the United States Supreme Court in equity?

A. Yes, sir.

Q. You made no recommendations as to any terms or conditions upon which New York might receive the relief that you suggest in your recommendations?

A. It is implied of course, that if the decree was made, that New York would withdraw or terminate this suit.

Q. But it is not suggested that New York should cease discharging into the waters of New York Bay?

A. Those stipulations do not.

Q. Well, I know; but your recommendation does not contain any such provision?

A. No.

Q. Why not?

A. Because this is an action in which the State of New Jersey is defendant, and I had hoped, and I still hope that after New Jersey consents to a stipulation, that New York will enter into some positive obligations as to what it will do in the same direction.

Q. But you do not suggest in your recommendation, any requirement on the part of New York, so far as the discharge of sewage is concerned?

A. I have not.

Q. And you do not suggest, and you do not recommend that she be required to cease discharging sewage into New York territory?

A. I have not so recommended.

Q. New Jersey is interested, is it not, in the discharge from New York into New York Bay?

A. Yes, approximately.

1143 Q. So far as your recommendation goes, it would permit New York to increasingly pollute the waters of New York Bay without any check being placed upon it?

A. So far as our condition goes, yes.

Q. Now, turning to recommendation B; why did you fix upon 75 per cent removal of suspended matter?

A. Because I think that degree should be required.

Q. Why?

A. I think it is proper and I think it is attainable, if I may place any reliance on Mr. Fuller's testimony.

Q. Attainable in what way?

A. By screening and sedimentation. Mr. Fuller proposes to keep out 85 per cent, even without any finer screens or even without any longer period of detention.

Q. He does?

A. He thinks that the plants as now built even without any chemical treatment will clearly, beyond doubt, remove 60 per cent, and it would take but little additional degree of refinement in the treatment to increase that 60 to 75 per cent.

Q. Then, in making this recommendation B, you are relying upon Mr. Fuller?

A. Largely, Mr. Fuller's testimony on that point.

Q. Where does he recommend that 75 per cent be removed?

A. He has stated that with the works as now being built, and not as stipulated to be built but as now being built, far less than the

1144 stipulations require, the removal would be between 50 and 60 per cent. He stated that by the addition of his proposed method of reducing the velocity of flow through the tanks, there would be no question, no doubt, as to the removal of 60 per cent; and then he says by another suggested plan of improvement, that by the use of chemical precipitants, the total solids could be reduced by 85 per cent, leaving only 15 per cent remaining.

Q. Did you accept that?

A. I accepted at least enough to reach 75 per cent.

Q. Did not you say that the chemical precipitation method was only an emergency measure, and could not be relied upon?

A. He states that. He states that and he refers to it there as an emergency measure.

Q. Yes; but I am asking you now why you accept it if it is only an emergency measure?

A. Because if it is only an emergency measure it can be employed continuously to a less extent than he used it there, and get out not 85 per cent but 75 per cent, or there are other ways by which it can be done. We have not stipulated how you shall remove it. I have simply depended on the fact that he says you can do it.

Q. That is why you put that provision into recommendation B, is it?

A. That is one of the main factors.

Q. Is there any other reason?

A. The other reason is that I know that by either building your plant in accordance with the stipulations, and not in accord-
1145 ance with the plans as now being executed, and also that by still further additions in the direction of sedimentation should be attained by a slower rate of velocity through, you can very decidedly improve the amount of solid matter removed. Now, if we start with Mr. Fuller's 60 per cent, it should be not difficult to get out 15 per cent more by what are known to be feasible methods.

Q. You have not placed the amount of removal at the prohibitive figure for the purpose of preventing the operation of the present work of the Passaic Valley Sewerage Commissioners; that is not your purpose?

A. No.

Q. Are you sure of that?

A. Do I understand that question correctly? Oh, no. I have not placed it at any figure with reference to preventing the operation.

Q. It is an arbitrary figure, is it not, 75 per cent, so far as your knowledge is concerned?

A. I do not quite know what you mean by arbitrary figure.

Q. An arbitrary figure is one that has no basis in reason.

A. No.

Q. What is the reason, then?

A. I shall be obliged to repeat what I have already said, that I am assured by your own expert that you can, under your present plant, not even under the one which the stipulations demand, remove 60 per cent. I know from my own knowledge that adequate and
1146 proper differences in sedimentation and screening could be used to take out 15 per cent more. Now, I add my 15 per cent, which I am using simply in order to give a very safe and reasonable figure to your own 60 per cent, and I get 75 per cent as the amount, and that I place as a reasonable or rational, or arbitrary figure, just as you prefer to call it.

Q. Would the removal of 75 per cent of the total solids result in the removal of 50 per cent of the organic matter?

A. I should presume it would give something like that. If it did not, then that would have to be a separate demand. I should presume that the removal of 75 per cent would result in the removal of 50 per cent of the total organic.

Q. How do you presume that? What do you base that on?

A. Well, on the general relation between the total organic and the total solids in ordinary sewage. Mr. Fuller in his testimony makes the quantity removed of one, just one-half the other.

Q. Yes.

A. And if he removed 60 per cent of the solids, he removes 30 per cent of the total organic matter.

Q. Do you adopt it?

A. Why, I have not followed that exactly. I think very likely his estimate, if he is able to remove 60 per cent, he would probably remove at least half of that. He certainly would, in ordinary sewage, the sewage of ordinary life. He would remove of organic matter probably at least half of the amount of total solids removed.

1147 Q. I ask you as an expert, what amount of total solids it would be necessary to remove, in order to remove 50 per cent of the organic matter to be consumed?

A. I should say that with the sewage of ordinary life, ordinary age, a removal of 75 per cent of solids would accomplish the removal of 50 per cent of the organic matter.

Q. Will the removal of 75 per cent of the total solids remove 60 per cent of the putrescible matter?

A. That would depend upon the methods which you used to remove the total organic matter.

Q. Well, you are putting this into a memorandum or a recommendation to be embodied in a decree?

A. Yes.

Q. You said it required the removal of 60 per cent putrescible matter?

A. And leave you to make the methods to make the figures coincide and obtain the operation, that is left to the Passaic Valley Commissioners.

Q. And you do not know and are not able to state the relation that these three requirements may have to each other?

A. The relation of those three requirements differs entirely in the method you use for treatment. If you were to confine your treatment to minute defined screens, you probably would not remove the total amount of putrescible matter called for here. If you use some other methods, you might remove the amount of putrescible matter, and thus relieve the amount of solids. That is left for the de-

1148 fendant to choose his methods, his combination of methods, that will most nearly produce those three results at the same time.

Q. Now, what relation have these standards to the conditions in the waters of New York Bay; for instance, why do you fix on 60 per cent of putrescible matter as a proper content of effluent which will be discharged into New York Bay?

A. Because I think that it would probably lead to safe results in New York Bay.

Q. Well, it would remove all the putrescible matter, and it would be still safe, would it not?

A. Sure.

Q. Do you know of any processes outside of chemical precipitation, or sprinkling filters that will remove 60 per cent of the putrescible matter of sewage?

A. There is no reason why you should not resort to chemical precipitation or sprinkling filters if you want.

Q. I ask you if you know of any other methods?

A. You would probably have to have means of oxydizing sewage—partially in order to remove 40 per cent putrescible matter. I am only asking you to remove 40 per cent and not 60 per cent. I want to correct my answer——

Q. So that the present plant of the Passaic Valley Sewerage Commissioners, under your recommendation, would be inoperative to produce the result?

A. I want first to correct my last answer, to make it distinctly clear, that I am answering on the basis of my proposal, not on the
1149 basis of your question. Your question predicts a removal of 60 per cent; my recommendations call for the removal of 40 per cent.

Q. All right, I will accept the correction, and ask you whether the removal of 40 per cent of the putrescible matter can be accomplished, except by chemical precipitation or sprinkling filters?

A. That is entirely for the defendants to ascertain. It is entirely possible to accomplish this removal. I have not attempted to go into the details as to how you should do it. That is for you yourselves to say.

Q. What I want to know is why you impose that requirement?

A. Because I consider these 3 per cents of remaining pollution to give us an effluent which, if discharged into New York Bay will be probably harmless; but if it carries not more than 25 per cent of its original solids, and not more than 70 per cent of its total organic, and not more than 60 per cent of its total putrescible organic, that it will probably be harmless.

Q. And you are imposing these conditions upon the effluent, with the knowledge that the present plant will not produce such an effluent?

A. With the belief that it will not.

Q. With the belief then that it will not, and that nothing short of oxydization will produce the result?

1150 A. I do not say that.

Q. You have said it?

A. No, I do not say that.

Q. What else will produce it?

A. It is not for me to disclose what you should do.

Q. I do not ask what we should do, but what can we do, that is what I ask you, an expert.

A. You can put in mechanical screens of very much finer openings than even the stipulation proposed. You can also put in very much longer detention periods in your basin, if you choose to do so. You can, if you wish, reduce your linear velocities of flow, which will contribute to sedimentation, very much more than even the stipulations demand, much more still than your plants will now do, and all those are before you, if you have to resort to chemical precipitation or sprinkling filters which you say.

Q. I ask you whether those devices which you have suggested, will remove 40 per cent of the putrescible matter, 50 per cent of the organic matter, and 75 per cent of the suspended matter?

A. And I answered that I think they can be—some of the numerous adequate improvements which Mr. Fuller has, in his testimony, testified to.

Q. What are they?

A. He testified to chemical precipitation; testified to aeration, testified to finer screens.

Q. He testified to finer screens at the end of the sedimentation period?

A. Yes.

1151 Q. Did you think that would accomplish any result?

A. Yes.

Q. You do?

A. I think you had better place them at the beginning of the operation, but it would have some result at the end. If the basin is not going to succeed in depositing solids, then a screen at the end of those basins would catch it, at least.

Q. Is it not a fact, Professor, that the conditions which you have imposed in your recommendation B, are incapable of being made by any processes, except those of oxydization of the sewage?

A. I presume an economical plan would employ oxydization, whether you can produce it without that, I am not prepared to say.

Q. Are you prepared to say how and at what expense an oxydization plant is being installed in the present works of the Passaic Valley Sewerage Commissioners?

A. I have not investigated that.

Q. Then you are imposing conditions, Professor, which you know to be prohibitive, are you not?

A. No, I do not; I know we are not imposing such.

Q. You know they are not; you know that they are prohibitive so far as the present plan is concerned, don't you?

A. I know that so far as the actual construction is concerned,
1152 these results probably could not be attained without modifying that construction, if that is what you mean by prohibition of this present plant—then, yes.

Q. What modification do you suggest to accomplish these results?

A. I have already indicated that before you undertake oxydization, you can increase your degree of removal of total solids by finer screens in place of stationary screens. You can still further reduce your total solids and still further reduce your organic matter, and to some extent your oxydizable organic matter by slower linear velocities, pro-

tected from disturbance by eddies and longer period of detention. You can also increase the degree of removal of your putrescible organic matter, if you choose to embark on Mr. Fuller's recommended plan of aeration.

Q. Yes.

A. Even without resorting yet to sprinkling filters.

Q. Well, then, those, in your judgment, produce the conditions which you suggest for the decree or stipulation?

A. As I said before, I think they can be accomplished, that these results can be accomplished with those features, and without going to sprinkling filters; but I doubt very much whether that would be the most economical way of doing it.

Q. What would be the most economical way?

A. A certain amount of oxydization accomplished by either
1153 a full resort to the operation of sprinkling filters, or to very thorough opportunities for oxydization, without going to the extent of spraying the sewage over broken stones.

Q. You saw the plant, did you not?

A. Yes, parts of it.

Q. Are either of these methods feasible at that point?

A. Not without reconstruction.

Q. In your judgment are sprinkling filters feasible at the location of the plant?

A. Land can be obtained contiguous to the plant for that purpose, if that is the purport of your question.

Q. How much will it cost to establish this system of sprinkling filters at the plant?

A. I have not made any estimate.

Q. Now, you have given some testimony with reference to the actual plant in operation not conforming to the stipulation. You say that coarse screens are not part of the plant?

A. No, I did not say that at all.

Q. Well, are they?

A. Yes.

Q. Coarse screens?

A. I said distinctly that coarse screens as stipulated, have been supplied.

Q. Did you see them?

A. I saw the place where the screens are to go. I did not see the screens.

Q. Are grit chambers or basins part of the plant?

A. They are part of the plant, as stipulated. I did not see any grit chambers, and I asked about them and I was not shown any.

1154 Q. Do you know whether or not they have been abandoned?

A. I do not think they are included in the present construction.

Q. I ask whether you know if they have been abandoned or not?

A. I do not know that.

Q. Then why did you say they have not been?

A. I did not say they had been abandoned.

Q. What did you say?

A. I said that they were not there at present, so far as my inquiries resulted; I did not see them.

Q. You did not see them?

A. And I asked about them and I was not shown anything.

Q. That is all you know about it?

A. That is all I know about it.

Q. Now, are fine screens part of the plant?

A. They are part of the plant, as stipulated; they are not a part of the plant as being built.

Q. That is your interpretation, that the actual screens as described by Mr. Fuller, do not comply with the stipulation; that is your interpretation of it, is it not?

A. The screen, as testified by Mr. Fuller, fully complies—probably fully—with the stipulation for coarse screens; but I want to make it clear again, if necessary, that the stipulations call for two entirely distinct kind of screens; the coarse screens and the fine mechanically operated screens, self-cleansing screens. The first

1155 of those are being built substantially as requires, I presume. I say, "I presume," because the stipulation is not explicit as to what the width of the opening shall be; but the self-cleansing mechanical screens which the stipulations clearly call for, are not being supplied.

Q. Are you prepared to say that there are not two sets of screens to be installed in the works on the Passaic River, coarse screens and the screens described by Mr. Fuller?

A. I am prepared to say that I made careful search for the other screens, and asked about them and was told that there was not any other screen except the one I was shown.

Q. Who told you that?

A. Either Mr. Taylor or Mr. Van Duyne—Mr. Van Duyne, I think it was.

Q. Who is Mr. Van Dyne?

A. He is one of the engineers of the Passaic Valley Sewerage Commission; not only that, but I am also depending on Mr. Fuller's testimony, in which he says that the cage screen, referring to the coarse screen, is not a literal compliance,—that is the mild way in which he puts it, with the stipulations; and giving the impression that doubtless the one is going to be the equivalent of the other. I can not think that Mr. Fuller really means to say that one coarse screen is going to be equivalent in clarifying capacity to one coarse screen, plus a fine screen, and that is the position he is taking in his testimony.

Q. Do you mean to be understood as saying that Mr. Ful-

1156 ler said there would not be a coarser screen installed in this plant?

A. By no means.

Q. Then why do you conclude that there will not be a coarser screen in accordance with the stipulation?

A. I did not conclude that. On the contrary, I repeat again, that there is a coarse screen being built substantially as stipulated.

Q. Do you mean to say that Mr. Fuller in his testimony asserted that there were not two sets of screens as required by the stipulation to be installed in the plant?

A. He did not say so in so many words, but he compares coarse screens with the fine screens.

Q. Did he say that there were to be no grit chambers?

A. Let me answer your question first.

Q. I thought you had answered it.

A. Not yet. I will read from Mr. Fuller's testimony on page 18, where he says, "In regard to the screens, I found that the screens as actually built consist of cage screens such as generally are used at the Boston Sewage Disposal Plants. They consist of iron bars placed so as to give a direct passage as one looks through the screens, a space of about one-eighth of an inch. These rods are placed in the cage in a staggered fashion, with the actual distance diagonally from bar to bar of about three quarters of an inch. These screens are cleaned by lifting one cage at a time, and thus removing the materials which are attached to the screen bars and to the receiving basket or receptacle at the bottom. These
1157 screens are hand-cleaned screens, and not screens of the revolving type. That is not a literal compliance with the provisions of the stipulation." I say there he is comparing the screens of the stiplation with those screens which he is describing, the bars of three-quarters of an inch in width. "But it is my opinion that it would produce an equal amount of clarification."

Q. Yes; then the screens he is describing are screen which, in his testimony, he says are equivalent to the fine screens?

A. He says they are equivalent in clarifying value of the screens of the stipulation.

Q. Yes; the fine screens.

A. "The stipulation screens" are the words he used.

Q. Is your understanding of his testimony that they are equivalent to both the coarse and fine screens?

A. In my opinion, they certainly are not.

Q. I did not ask you that. I asked you whether it was your understanding of his testimony, that they were equivalent to the coarse screens and the fine screens?

A. I *so* judge that he intends to convey the impression, at least, that these cage screens are equivalent to the screens called for in the stipulations, which are two in number, coarse and fine.

Q. Then they are equivalent to the fine screens, are they
1158 not, in his testimony? In his opinion you would infer or I infer, at least, from his opinion, that he thinks they are. He states they are at least equivalent.

Q. So that what he is saying then is that these cage screens are equivalent to the fine screens as you term them, stipulated in the stipulation?

A. Well, I want to repeat again that he is not comparing the cage screens with what he calls the fine screens, but he is speaking of the screens of the stipulation. I would not go as far as to call the screens in the stipulation very fine screens. In fact, .4

inch would be accounted a wide opening for self-cleansing mechanical screens at the present time, but he is removing all doubt on that by comparing them directly with the screens of the stipulation, and expressing the opinion that the screens which he found there, the cage screens, with bars ¾ of an inch apart, will have the same clarifying effect as the screens of the stipulation, which involve two screens, a coarse screen and a finer screen.

Q. Then if it is equivalent to both, it is equivalent to the other one, is it not?

A. Not necessarily at all.

Q. Why not?

A. If it is equivalent to both, it would be more than equivalent to either one singly.

Q. It is more than equivalent then, to either one singly?

A. Yes. If equivalent to both.

Q. It is more than equivalent then, to the .4 aperture
1159 screen?

A. Yes.

Q. Then it is a fine screen, finer than the ¾ inch screen?

A. But still a coarse screen, as compared with the modern term "fine screen."

Q. Do you understand that to be the coarse screen that the stipulation required?

A. The stipulation is very clear and emphatic in calling for two screens—a coarser and a finer screen. A screen whose distance apart between bars is not stated, but the purposes are stated, to remove coarse floating material, or large floating material, than another self-cleansing mechanical screen, whose openings shall be not less than .4 of an inch.

Q. Now what I ask you is, what is your justification for testifying that the works will not contain the coarse screen that is prescribed in the stipulation?

A. As I have already stated, first, because I did not find any on inquiry; second, because Mr. Fuller in his testimony gives one very clearly the impression that there is not to be a mechanical screen, a self-cleansing mechanical screen there, and he attempts to excuse the absence by saying in his opinion he thinks it will have an equivalent effect.

Q. I was not asking you about self-cleansing mechanical screens; I was asking you about coarse screens. I want to know what is your justification for the testimony you have given that the works will not include coarse screening?

1160 A. I have not said so at all.

Q. Do you say so now?

A. I do not.

Q. Do you know whether it will or not?

A. I believe it will, because I saw a place for coarse screens.

Q. For a coarse screen?

A. Yes.

Q. As distinguished from the cage screen?

A. No, no.

Q. Do you mean to be understood as saying that there will not be a coarse screen in addition to the cage screen, which Mr. Fuller described in his testimony?

A. The place which I saw for screens at the works was for screens which are to be removed and cleaned by hand. You may call those cage screens, if you wish. It is a stretch of the term to apply that name to them at all, because a cage screen has a regular basket with bottom, and one or three sides made of bars, and has considerable depth in the line of sewage flow, considerable thickness. Now, this screen which is being installed, I infer from the space allowed for it in the concrete walls, will be very narrow up and down. I am not making any point of that. I am simply saying that that is to be a removable screen, and is to be a hand-cleaned screen, not only because I was shown the way it was taken out, but because Mr. Fuller testified to it on page 18.

Q. I now ask you what justification you have for saying that there will not be another screen in addition to the one that you have testified about and described?

1161 A. I have already answered that twice.

Q. Answer it a third time.

A. First, because I did not find any place where such screens could be installed, nor any mechanical devices for operating them, or any power to drive them; and second, because Mr. Fuller goes to considerable pains to make it appear that the coarse screens, namely, the hand-cleaned screens, the cage screens, which he speaks of here, are equivalent in their effect to the screens of the stipulation, and the screens of the stipulation include the coarse and fine screens, and that is my reason for testifying.

Q. I can assure you positively that you are mistaken.

A. Very well.

Q. With reference to the grit chambers, do you mean to say that they are to be omitted from the works, when completed?

A. I do not know. I have fully explained my ground for saying what I did about them.

Q. You did not say that at all.

A. I did not see any—I asked where they were, and I was not shown any.

Q. Well, unfortunately, you can not put these people on the stand. You were not shown them; that is your answer, is it?

A. Yes.

Q. Now, if Mr. Fuller's judgment is correct, and the screens which he testifies are to be installed as cage screens, are equivalent in operation to screens having one-eighth of an inch aperture,

1162 and not .4, are those fine screens or are they not?

A. There is no screen considered which has an aperture of one-eighth of an inch.

Q. Did not he testify that they were substantially such screens?

A. No; his testimony is straight, if you understand it, and if you interpret his words correctly. My sketch shown in one of the exhibits makes that, I think, perfectly clear. One-eighth of an inch has nothing whatever to do with the screen capacity of those screens

that Mr. Fuller is testifying to. The one-eighth inch is simply the visible width of daylight you can see, if you look through the screen, the direction of the sewage flow. The sewage does not have to flow in that straight line. The sewage makes a zigzag movement. It steps aside and passes one bar, and then goes a little sideways to another bar and finds an opening three-quarters of an inch wide in each of those.

Q. It is not then your opinion, and you do not agree with Mr. Fuller when he says that these screens will produce an equal amount of clarification to those stipulated in the stipulation?

A. It is not my opinion that they will.

Q. You disagree with Mr. Fuller?

A. I disagree with Mr. Fuller. It is my opinion that the screens as described by Mr. Fuller, and the receptacles for which I saw myself at the works, will not have the sample clarifying effect as screens stipulated in the specifications, being two in number, coarse
1163 and mechanical screens, with .4 inch maximum opening.

Q. He testifies as you have read, "These screens are hand-cleaned screens and not screens of the revolving type. That is not a literal compliance with the provisions of the stipulation, but it is my opinion that it would produce an equal amount of clarification." You do not agree with him?

A. I do not.

Q. What plants have you ever constructed for the purification of sewage?

A. I have not constructed any myself.

Q. What have you operated?

A. I have never operated myself.

Q. What do you know about the operation of the screens of the type which Mr. Fuller describes?

A. I know them by observation.

Q. Where?

A. At numerous disposal plants, almost every disposal plant has screens of this sort. Screens of this sort are used at the Boston main drainage works.

Q. Have you seen them?

A. I have.

Q. Where have you seen the screens of the type described by the stipulation?

A. The stipulations are a little bit liberal in defining what is meant. They must be self-cleansing screens. It means that they are screens which are movable in operation, when they are functioning so arranged that they will clean themselves, and also
1164 mechanical screens; that is, movable screens require the movement and require power to drive them. I have seen those in various places. We have one up here at the Dyckman Street plant. I have never seen that one, but I have seen screens of that type. They are used in a number of places.

Q. Is the Dyckman Street screen a screen as described here having apertures, or openings of not .4 of an inch?

A. Very much finer than that.

Q. Don't you know that the screen that is intended to be described in the stipulation is the Hamburg screen?

A. The stipulation did not say so at all.

Q. Don't you know it?

A. No, I do not know it, and there is no warrant for saying it must be the Hamburg screen. They may have had that screen in mind as complying with that requirement.

Q. You place your judgment as an operating sewer man, or expert, as against Mr. Fuller's, do you?

A. In that matter of the equivalent clarification I do.

Q. Yes; and the determination of the matter will depend upon the qualification of the two experts, you and Mr. Fuller?

A. Not necessarily. It would depend upon an impartial examination by a disinterested party.

Q. Now, what is the time of the greatest exhaustion of oxygen in the waters of New York Bay, normally?

A. You mean, what is the date?

1165 Q. What is the time of year?

A. During the late summer and fall.

Q. Well, that is pretty long; that is four months. Can you not place it within closer limits than that?

A. No. I do not know that, having attained a minimum, it changes suddenly. It probably does undergo some slight change, but it is a thing which, decreasing to a certain minimum, stays about there until the conditions improve.

Q. Well, naturally; how long does it take for the conditions to improve, after arriving at the minimum?

A. After a week or two of cold weather which sets in, it will begin to effect the oxygen content. If a fresh water freshet occurs, or if an exceedingly high tide occurs, it will temporarily improve the conditions as to oxygen content.

Q. What month covers the minimum of oxygen content, in your experience or knowledge and judgment?

A. I should say the minimum would be reached somewhere in September or October.

Q. You do not agree with Prof. Phelps when he says the minimum is in August?

A. If he says in August, I should pay great respect to his judgment; but I do not believe that he had reference to a season when the warmer weather coming in was late in August, and when the dry weather was late in August, with the low dilution.

1166 Q. Do you mean to be understood that November is the month of minimum content of oxygen content of the waters of New York Bay?

A. No; it probably is a little later than the minimum.

Q. In your graphic delineation of the fallacies of Mr. Whipple, did you not assume that the time of his observation in November was the minimum oxygen content?

A. No.

Q. You did not?

A. An examination of the diagram shows that. My testimony said "At or near the time of minimum."

Q. How near?

A. My diagram shows that his point is after the minimum.

Q. How much after the minimum?

A. You can judge yourself. It is on this chart, Exhibit No. 255. His point of charting is after the point *b*.

Q. How much is that in time?

A. I have not attempted to indicate that time. I have simply tried to be fair by showing that it was after.

Q. It is after the point of the letter *b*, is it?

A. Yes.

Q. What is the scale of this diagram?

A. I have already said that was not drawn to scale.

Q. Tell us if you have attempted to indicate it, how much after the period of minimum oxygen content, the date of Mr. Whipple's observations in November were?

A. I should say in the ordinary year that it would be from half a month to possibly a month after the minimum.

1167 Q. Then you place your minimum in October, do you?

A. My answer to that would place the minimum at the middle of October, or first of October.

Q. You place the minimum of oxygen, at the middle or first of October?

A. Yes.

Q. If Prof. Phelps places it in August, you do not agree with him?

A. I do not believe he placed it in August.

Q. I asked you if he does. Of course you do not agree with him naturally, if he places it then.

A. No. I think the minimum comes after August.

Q. Now, with reference to Mr. Fuller's suggestions of additional arrangements which might be introduced into the Passaic Valley plant, I believe you have said that you approve of the suggestion of the reduction of velocities in the sedimentation basins?

A. Yes.

Q. Only you do not think it can be accomplished for the amount that he claimed?

A. I think so.

Q. It can be accomplished, however?

A. Yes, but not without some internal reconstruction of the basins.

Q. Yes. Do you place any figure upon the amount necessary to accomplish this result?

A. I have not.

Q. The introduction of finer screens, after the sedimentation process is completed, do you approve of that as a method of improving the effluent?

A. You mean as a permanent improvement, or as an ex-

1168 pedient for very hot weather when the staff fails to carry out its removal of sewage?

Q. I have not specified. I ask you whether his suggestion of the introduction of finer screens at that point will result in a better effluent?

A. I want to know whether you followed Mr. Fuller's suggestion, which is an emergency method to be used in hot weather, only when the operating men do not remove the sludge at frequent intervals?

Q. I want to know whether you approve of it as an additional arrangement which will tend to improve the effluent.

A. I do not believe it would accomplish the results operated as Mr. Fuller proposes to operate them. I do not believe it would accomplish the results which he desires to accomplish, namely, the removal of the gas lifted sludge.

Q. Then you do not approve of it at all, do you?

A. I do not extend my condemnation of it to a proper installation for removal of normal solids, from the liquid solid. Mr. Fuller is proposing, if you read his testimony, an emergency measure to screen out not the normal solids from the sewage, but the gas-lifted solids, or sludge in the bottom.

Q. I was not asking you about that—the introduction of finer screens before the sewage comes into the sedimentation basins. I am asking you about his suggestion as made, a fine screen introduced after the sedimentation process has been completed.

A. And I repeat my question as to whether you mean under the conditions that Mr. Fuller stated in his testimony or not, or
1169 normal or regular operation?

Q. I repeat my question, Professor, and ask you to answer it if you can; if not, do not answer it.

A. And if you insist on declining to state what you mean by the question, I shall have to answer it in two ways. If you mean that you assume the conditions that Mr. Fuller did, hot weather, failure of the operating staff to remove the sludge at frequent intervals, and that the fine screens are introduced after the detention basins for the period of catching or detaining this gas in the sludge, then I may say I do not think it will accomplish the purpose. Even if it does accomplish the purpose at the time, it is only a temporary expedient occurring during these two occurring emergencies; namely, the hot weather and the failure of the operating staff to remove the sludge. On the other hand, if you mean to ask whether or not these same very fine screens, if introduced permanently after the detention basin, would be beneficial, then I will say that they would certainly have some effect; but that is not the way I should want to install them.

Q. But if they are installed, as suggested by Mr. Fuller, whether it be as an emergency proposal to produce results arising through the emergency you describe, or whether it is a permanent condition, they will tend to further clarify the effluent?

A. They will not, when not in operation. They only propose to operate them during a short period.

1170 Q. If they are installed in the outfall from the sedimentation basins,——

A. You can divert the sewage into them, or out of them, through them or not; he does not propose to operate them all the time. He installs them all the time, but he does not propose to operate them all the time.

Q. You interpret his testimony as a temporary emergency proceeding, do you?

A. Yes.

Q. I read to you from the testimony (reading): "The fine screens would be guarding against the accidental or abnormal face of tank performance, and not the normal or regular performance." Does that indicate in your mind that the screens are not in constant operation?

A. My interpretation of his testimony there, beginning at "but it is practicable, if need be to install very fine screens, to guard against the passage into New York Bay of gas-lifted sludge to the bottom of the sedimentation basins. In other words, the fine screens would be guarding against the accidental or abnormal failure of tank performances, and not the normal or regular performance." From that I infer that he intends to install screens, and keep them installed, but not to have them operated, except under these emergency conditions.

Q. That is to say, who would determine, when the staff are careless, when they should be operated, then?

A. Some other equally careless member of the staff. I may be wrong in my interpretation of his meaning, but I infer from
1171 his later sentence there, in other words, the fine screens will be guarding against the accidental or abnormal face of the tank performance, and not the regular ones, and I am assuming that he means not to operate them all the time, but I may be wrong.

Q. If you are wrong in that, do you wish to modify your testimony?

A. If I am wrong, I will say those fine screens would produce some beneficial effects, as long as they are in operation.

Q. Now, the process of aeration, Professor, you disapprove of that as an additional arrangement, do you not?

A. I do not think it will have any material effect in producing beneficial results. I think it will be accompanied by undesirable facts.

Q. Why?

A. As I explained before, every cubic foot of air put into the sewage by compressors or fans, or blowers, has not to come out again. It goes in as pure air under compression. It comes out many times its volume, and comes out bringing away the odors which it has inevitably absorbed from the sewage.

Q. That is a nuisance within the State of New Jersey, however?

A. Yes.

Q. But it does not affect New York in any way?

A. No.

Q. Would it benefit the effluent?

1172 A. Whatever effect would be produced would be beneficial, but I want to show—my purpose in bringing out the ob-

jection was that if it is found to be a nuisance, it will not be tolerated over there, and it will be prohibited, and that even if it operates, the measure of improvement would be so slight as to be immaterial, as being counted in one of the improvements which the Court asks to have recommended.

Q. But did not you a little while ago testify that the Passaic Valley Sewerage Commissioners, by the introduction of additional arrangements at different points including aeration, would produce a better effluent; do you not remember testifying to that?

A. Yes.

Q. Well, then, it may have a beneficial effect.

A. The aeration does not necessarily go to the method which Mr. Fuller here expressly stipulates—blowing air into the sewage.

Q. Where did you pick out that Mr. Fuller suggests that the blowing of air should be done, at what point?

A. At page 29 he says, "In addition to the question of guarding carefully against permitting stranded solids to accumulate in the sewers, I mention that aid might also be secured, by blowing air into sewage at one or more points along its line of travel from Paterson to the pumping station on the Newark Meadows," and again: "By blowing in air, I do not mean to imply," and so forth.

Q. Now, are there any points within the limits——

A. Farther down on this same page he says: "I have made
1173 a study of blowing air through a perforated pipe system installed within the trunk sewer itself below the Paterson City limits," showing that he intends to introduce the air in a perforated pipe. Therefore it will be compressed air.

Q. And below the City of Paterson?

A. Below the City of Paterson, and above the pumping station.

Q. What?

A. And above the pumping station.

Q. The purpose being what?

A. As he says, "To aid as a preservative."

Q. Will it serve to aid as a preservative, if it is introduced, as he says, immediately below the City of Paterson?

A. Whatever beneficial effect it has will be to tend to cause the decomposition of sewage to be carried out by the aerobic method, that is to say, by orderless bacteria; that is to say, bacteria that do not produce odors, but he repudiates any intention of oxydizing, by saying distinctly, "I do not mean to imply I am speaking of oxydization, but the delivery of air into the sewage to aid as a preservative, is to prevent putrefactive processes being established."

Q. For the purpose of rendering sewage less stale, until it reaches the pumping works?

A. Yes.

Q. Is not that the purpose?

A. Yes.

Q. Will it accomplish it either in whole or in part?

A. It may have some very trivial effect.

1174 Q. What do you mean by "trivial"?

A. I mean very small in amount.

Q. Unappreciable?

A. Unappreciable.

Q. Now, the duration and rating on pumping, Professor; do you think that is impracticable as an arrangement which will serve to insure the character of the effluent when discharged into New York Bay?

A. I think it is impracticable, so far as adjusting his variation in pumping rate to the variation in tidal flow past the nozzles at the dispersion area. I think it will be objectionable in some of its consequences.

Q. What are the objectionable consequences that you anticipate?

A. That the variation of the rate of pumping will produce a variation in the flow, not only from the detention basins, but also in the trunk sewer tunnel above the pumping station. Thus, if the pumping is reduced to one-half its velocity, or is stopped altogether, the discharge and flow in the velocity through the detention basin will be reduced in velocity correspondingly; and in a similar manner, if the pumping is reduced to one-half, or is stopped, the flow in the tunnel will be diminished, and as the flow in the tunnel is diminished, the deposition of solids in the tunnel will increase, and sedimentation will take place in the tunnel.

Q. Then you think, rather than being an advantage, that
1175 this arrangement would be a disadvantage, do you?

A. I think in the aggregate it would be a disadvantage.

Q. Now, chemical precipitation——

A. I want to make it clear that I think it will be disadvantageous, operated as this plant is built. If it were intended to design a detention basin, as used to be done where the method of tidal detention was employed, where the sewage can flow constantly all the time through the sewer, and flow into a basin which simply accumulates and holds it, then it would be free from this objection, but that is the contrary.

Q. How do you know it is the contrary?

A. Because it does not say a word about adding another detention basin.

Q. It can be done, can it not?

A. You can add another detention basin if you wish. Then you are up against the difficulties attending tidal detention basins.

Q. In this you differ with Mr. Fuller again; that is what it comes to, does it not?

A. In what?

Q. In the result of this expedient.

A. I do not think Mr. Fuller has expressed himself very clearly as to what the result will be.

Q. Then you do not know whether you disagree with him or not?

A. I think in part it would be impracticable, and in part undesirable.

Q. Do you agree or disagree with the views expressed by Mr. Fuller in his testimony?

A. Well, Mr. Fuller is perhaps safe by saying, "That aid
1176 might also be secured". I am not denying and have not denied but what—I beg your pardon—then I was reading from the aeration part. You are now speaking of the variation in pumping?

Q. Yes.

A. Mr. Fuller is careful to keep away from any definite expression of opinion. He says "If at certain intervals during the day sewage was pumped at say 1/2 the ordinary rate of speed, and at other intervals a corresponding greater increase above the normal, two things could be accomplished". He states that if a certain thing were done, two results would follow. I do not say that he expressed his opinion as to the efficacy or the results that are to follow from that.

Q. I draw your attention to the beginning of that paragraph on page 30: "One other feature I should mention for better operating conditions, and that is the variation in the rate of pumping sewage from the trunk sewer into the basins from whence it will flow by gravity to New York Harbor".

A. That is an indication there that you will get better results. He means to imply that that will better conditions; and I repeat what I said before, that I think his means of accomplishing the better results by varying the discharge through the nozzles to correspond with the discharge of tide past the nozzles, that that is impracticable, and that he can not time the one to fit the other.

1177 Q. You do not agree with him, in other words?

A. I repeat my answer, that I think he can not adequately time them so that the one will fit the other.

Q. You do not agree with him that that is a means of bettering the operating conditions?

A. Well, I do not wish to say, but if he can accomplish his actual reduction of discharge through the nozzles at the same time and to a corresponding degree when the tidal motion passes the nozzles, I do not mean to say that he would not thereby accomplish an improvement in operating conditions, but I think it is unattainable that he should do that, and in doing it he will impose on the system the undesirable result of causing sedimentation in the trunk sewer.

Q. I will read from his testimony on page 31, Professor: "In speaking of these volumes and these velocities, I wish to point out here the fact that the tide does not come to a standstill and turn at the same hour at the top and bottom depths of the dispersion area; that the mean velocity of a full vertical depth of water over the dispersion area is found to average not less than three inches per second, although it is a fact that there may be places where the velocity is less than this; so that with partial retention of the sewage in the basins and in the trunk sewer as found most convenient in operating the pumping station at various rates, would serve these two purposes, and they would be beneficial to the end sought in the stipulation."

1178 You do not agree with that—"it would be beneficial".

A. I repeat again, that if he could time his rate of pumping to correspond with the varying rate of a tidal flow past the nozzles,

then he will accomplish an improvement at the dispersion area, but whether he accomplishes that or not, if he changes the rate of pumping, he will impose an impairment at the pumping station miles away, and in the trunk sewer tunnel, which is above the pumping station even, because that is the only sewage detention basin he has got. He can not increase the capacity at the sedimentation basins, as they are already full of sewage. He must, therefore, use the trunk sewer as his only reservoir of storing up the accumulated sewage that comes down at a fixed rate, if he reduces his pumping to a slower rate.

Q. Do not you understand that the sewage is pumped into the basins?

A. Surely, and if he stop pumping, it will stop going into the basins; but he does not stop the sewage coming down whole in the tunnel.

Q. No. Then as a whole, in your opinion, would the suggested arrangement be beneficial to the result in the stipulation?

A. In an immaterial way, and if he is successful in properly timing it.

Q. It would be beneficial?

A. It is a balance between an uncertain benefit that may follow, and an enormously larger certain impairment. It is a bene-
1179 fit at one point possibly which perhaps he may be able to attain against an impairment that is certain to follow at another point.

Q. Yes; and I am asking you what your opinion is, taking everything into consideration, as the result of this arrangement.

A. Taking the chance of securing slight impairment against the certain chance of securing an impairment, I should not want to risk it, and should not think it would be a desirable expedient.

Q. And you do not agree with Mr. Fuller?

A. I do not, to the extent of my answer.

Q. Now, the fifth suggested additional arrangement is chemical precipitation; is it not?

A. I think so.

Q. Do you agree that that method, if applied at the pumping station, can be made to remove 85 per cent of the solids from the sewage?

A. I have not made any study of the conditions under which this sedimentation would take place, nor the exact characteristic of the sewage, therefore I can not answer, and I will accept Mr. Fuller's statement for what it is worth. He said it can.

Q. What I want to know from you is what, in your opinion, is his statement worth?

A. Well, if he says he can remove 85 per cent, I should be inclined to accept his statement that he can. He knows more about that sewage possibly than I do.

1180 Q. The process is a well-known one?

A. Yes.

Q. So that you are not prepared to deny the beneficial results of

that arrangement, if introduced into the works where it was found necessary?

A. No.

Q. You have characterized it as an emergency measure; what do you mean by that?

A. I am using his own terms, he does not intend to use it permanently, but only as an emergency measure.

Q. What measure—what emergency would result in the use of it?

A. He says "I might proceed also with the last point which I have considered in this program of betterment procedures, and that is to refer to this fact that if any extraordinary condition should arise during a very hot season, it would be impossible to increase the removal of total suspended matters and of organic matter from the sewage passing through these basins, by resorting to the use of chemicals. By that I mean to say that lime and sulphate of alumina, or sulphate of iron, might be added to the sewage as it enters these basins. That chemical treatment would promote the clarification in conjunction with the sedimentation resulting from the flow of the sewage through the basins, and in my judgment would bring the removal of total suspended matters from about 60 to 85 per cent, and of the total organic matter from about 30 to 50 per cent." Then the emergency is a condition which requires something more than screening and sedimentation, is it not?

1181 A. He says he is using it for emergency, and for extreme hot weather.

Q. Extreme hot weather is characteristic of summer time, is it not?

A. Yes.

Q. And do you conclude that the use of chemicals would be less effective in other weather than in hot weather?

A. I am not making any point of the efficiacy of the chemicals in different times of the year.

Q. So that if that method was applied throughout the year, you are satisfied that it would remove 85 per cent of solids, and 50 per cent of the organic matter in the Passaic Valley sewage?

A. I am supposing that Mr. Fuller said he could do it.

Q. Said he could do it?

A. He said that it will have that result.

Q. Do you believe it will have that result then?

A. I believe he knows more about that sewage and the adaptibility of the chemical treatment than I do.

Q. Can you state the relation that the oxygen content of the water in the month of November in any year, may have to the oxygen content in the month of May; have you any formula, in other words, as to the variations between those two months?

A. I think we may have some data that we can compare. I have no formula; but in general, the value in November would, under average conditions, be not more than 80 per cent of the value

1182 in May, and probably it would be a good deal less than 80 per cent. Mr. Whipple's own exhibit is in point on that very matter. His comparison shows a decided larger content in

May than in November, in spite of the declining effect in the river in general during those intervening years.

Q. Do you conclude in arriving at the fallacy which you have suggested, that Mr. Whipple failed to recognize the difference in values between the two months?

A. I have not tried to account for his testimony.

Q. Well, you are prepared to say, are you not, that he must have failed to recognize the difference in values, so far as oxygen content is concerned in the two months?

A. I do not care to characterize Mr. Whipple's intention, or what he has failed to do, or has not. I simply want to——

Q. You do not like to do it, but I will have to press you to do it. Answer the question; repeat the question.

(The question was repeated as follows:) "Well, you are prepared to say, are you not, that he must have failed to recognize the difference in values, so far as the oxygen content is concerned in the two months?"

Dr. O'Sullivan: I object to the question on the ground that Mr. Whipple himself declared that these determinations stood barely for what they showed, and in no way were either comparable to an indication of the conditions of the waters at any other time.

1183 The Commissioner: Note the objection of counsel for the complainants.

Q. Answer the question, please, Professor.

A. I can not say whether Mr. Whipple overlooked that fact to which you refer, or not.

Q. I understand, however, that you do not agree with him that the results indicate no considerable change in the oxygen content of the waters since 1909.

A. I agree with him fully. In other words, I accept his observations as being accurately and faithfully made, and therefore I do accept that he probably found the water to contain more oxygen in May, 1919, than he did in November, 1909.

Q. Is that your answer?

A. Yes.

Q. You have not any other answer to make to that question?

A. No.

Q. Do you agree with him in his opinion that the waters of New York Bay do not show any appreciable reduction in oxygen content between the years 1909 and 1919?

A. I have not read Mr. Whipple's testimony in full, but if he said that, I should have to differ with him.

Q. You differ with Mr. Whipple thereon?

A. Yes.

Mr. Riker: That is all.

Redirect examination.

By Dr. O'Sullivan:

Q. In considering the design and construction of sewage
1184 disposal system, do you take into consideration the condition of the sewage to be treated?

A. Certainly.

Q. Comparing the sewages of the Passaic Valley trunk sewer, as it will be when discharged at the outfall at Robbins Reef, with the sewage that you have already described as being likely to be discharged at Red Hook, how do they compare as to their age, their septicity, and their general character?

A. The sewage discharged at Robbins Reef through the Passaic Valley System would be very much older, probably several times as old, on the average, as the sewage discharged through the Red Hook outlet. That greater age would cause a greater staleness and a greater septicity, and a much greater production of odors and obnoxious fumes, color and so forth.

Q. What is the color of septic sewage?

A. It is black.

Q. Is it more or less buoyant than fresh sewage?

A. Unless it has had its solids all removed, it is more buoyant.

Q. When you stated that the discharge of sewage at the outfall at Red Hook, after screening and sedimentation would not create a nuisance, did you contemplate present conditions or conditions as they might exist, after the Passaic Valley trunk sewer would be in operation?

A. I tried to include that in my answer. I intended to speak of it as not assuming the other to exist.

Q. What other sewer?

A. The Passaic Valley sewer, the Passaic Valley outfall.

1185 Q. You have stated in answer to a question put to you by Mr. Riker, that chemical precipitation is a well-recognized mode of treating sewage. I ask you if it has not been discarded, where it had been employed at the outfalls on the Thames near London, New Bedford in our own country, and in other places?

A. It has been abandoned at a large number of places. It remains in operation in a few places, but all of those places are attended by very peculiar circumstances, to make that still the better system to employ. In the main, however, it is no longer considered a current method.

Q. Mr. Riker directed your attention to the stipulation known as Complainant's Exhibit No. 135. I ask you if the plant described in that stipulation, with the suggested methods of improvement offered by Mr. Fuller, if that plant will fulfill the guaranteed stipulations in Complainant's Exhibit No. 135?

A. In my opinion they would not.

Q. Have you ever held an official position under any administration in the City of New York?

A. Not a salaried official position. I have been retained on various

occasions by different bureaus as an expert, and as a consulting engineer, but I have never occupied an official salaried position.

Dr. O'Sullivan: That is all.

1186 Recross-examination.

By Mr. Riker:

Q. Professor, when you testified that the discharge of an effluent of 200,000,000 gallons of sewage a day at Robbins Reef would produce a nuisance there, did you assume that the Red Hook plant would be in operation, or did you not?

A. I did not.

Q. So that 200,000,000 gallons a day from the Passaic Valley sewage system, without any immediate disposal of a large volume of sewage, will produce a nuisance, where 200,000,000 gallons of effluent discharged from Red Hook or Brooklyn will not produce a nuisance, is that the result?

A. That is exactly the result, taking into account the wide difference of character in the two sewages, and in the two effluents.

Q. What wide differences in the effluent do you take into account?

A. In the case of the Brooklyn sewage, it comes to the treatment works, comparatively fresh, as compared with the New Jersey sewage. Screens, therefore, detain and divert a much larger proportion of this total organic matter than would be the case if that same sewage had been two or three or four times as old. In the second place, the screens employed at Brooklyn are very much finer than those which are stipulated to be employed, even in the stipulations; and in the third place, the effluent, after passing the screens at Red

1187 Hook, is comparatively a fresh effluent; whereas, the effluent from the Passaic Valley system, being many, many hours old, and traveling many miles, is in a far more advanced stage of decomposition, and is in a black putrid state.

Q. What sedimentation is proposed for the Red Hook effluent?

A. I can not give the details of it.

Q. Is there any?

A. There are the grit basins, and I do not know whether any further addition or not. I do not remember.

Q. Are you not a little rash in predicting what will be the character of that effluent, without knowing what will be done to the sewage?

A. As long as you know it is fresh sewage, and it is screened, the main dependence is not on sedimentation there.

Q. As a matter of fact, is not the distinction you have in your mind, the fact that one comes from New York, and the other comes from New Jersey?

A. Not in the slightest. I have tried to free my mind of that difference.

Q. I ask you whether the sewage effluent discharged from the works of the Passaic Valley Sewerage Commissioners, if additional arrangements may be added as suggested by Mr. Fuller, will produce

an effluent which, when discharged at Robbins Reef, will result in an annoyance?

A. I think it will.

1188 Q. You think it will?

A. Yes.

Q. That effluent will have had removed from it 80 per cent of the solids, Prof. Landreth; you bear that in mind, do you not?

A. Do you mean in your question, that all of Mr. Fuller's arrangements are to be added at the same time, simultaneously?

Q. I intended by my question exactly what Dr. O'Sullivan intended by his question. Did you understand what he intended by his question?

A. Yes.

Q. What did he intend by his question?

A. That every one of these operations would be employed at the same time.

Q. Every one would produce the result, is that what you understood by it?

A. Yes.

Q. I did not intend that. I intended the introduction of the expedients and arrangements that Mr. Fuller has suggested.

A. Operated all the time?

Q. Yes; operated all the time—will a nuisance be produced?

A. Are you imposing Mr. Fuller's improvements on top of the stipulated plant, or the plant as being built?

Q. I am doing just what Dr. O'Sullivan did—upon the plant as stipulated; will there be a nuisance created at Robbins Reef?

A. Well, if Mr. Fuller removes 85 per cent of the solid matter, and 50 per cent of the total organic matter, and employs his other improvements, I do not think there would be a nuisance there.

1189 Q. And you get a result which complies with your second recommendation, do you not—the removal of more than 75 per cent of the total solids?

A. 85 per cent.

Q. And the removal of at least 50 per cent of the organic matter?

A. Yes.

Q. And any question whether 40 per cent of the putrescible matter would be removed?

A. I do not know that it would not, but I said I do not think there would be a nuisance there.

Q. Will the effluent produce the result that is guaranteed in the second section of the stipulation?

A. Would they under these conditions?

Q. Yes.

A. Building the plant as stipulated, not as built, and to apply all of Mr. Fuller's improvements at the same time, too?

Q. Yes.

A. I think possibly they might meet the stipulations.

Q. One other question. Do you now refer, when you speak of the plant as built, to your understanding of how the plant is being built?

A. Yes. I want to qualify my last answer. You asked if I ex-

pected a certain result to be attained, and I asked you if you intended certain things. I should have asked you if you intended to guarantee that Mr. Fuller would remove 85 per cent of the total solids, and 50 per cent of the total organic matter. I assumed
1190 that in my answer.

Q. You have already accepted that, have you not, as being the result of Mr. Fuller's knowledge, which is superior to yours?

A. Yes; and my answer assumes that he will accomplish that, my answer to this question.

Q. And you have no doubt that if he wishes, he can accomplish it from his superior knowledge of the sewer and the science generally, he can accomplish it?

A. If he cares to accomplish it, he would be held to do what he agreed, I judge.

By Dr. O'Sullivan:

Q. As a Sanitary Engineer, Professor Landreth, would the devices prescribed in Complainant's Exhibit 135, and the additions through the suggested improvements testified to by Mr. Fuller, cause 85 per cent of the solids to be removed?

A. In my opinion, 85 per cent of the solids would not be removed, as he intends to operate them.

Dr. O'Sullivan: That is all.

By Mr. Riker:

Q. Then you do not accept Mr. Fuller's statement that 85 per cent of the solids can be removed in the way that he prescribes?

A. I do accept his statement that 85 per cent can be removed, but I do not think they will be removed by the method which he employs.

Q. Then you do not accept his statement that 85 per cent
1191 can be removed in the way that he describes?

A. I have said I do believe he can remove 85 per cent, if he says he can; but if you will remember, he is applying that clearly and distinctly in his answer to an emergency or extreme extraordinary condition during hot weather.

Q. Well, if he can remove it during emergency conditions in hot weather, why can he not remove it at all times?

A. If he takes the proper means of applying to the best advantage his method of chemical precipitation, and is sure that he can remove 85 per cent, and does it all the time, then my answer to your question, the second before the last, would be that I do not think a nuisance would be created at Robbins Reef, assuming that 85 per cent of the total solids is removed all the time, and 50 per cent of the total organic matter is being removed all the time.

Q. Do you accept or do you not accept Mr. Fuller's statement that by chemical precipitation at this point he can remove 85 per cent of the solids and 50 per cent of the organic matter?

A. I do not know that he can not.

Q. I ask you whether you accept that, do you?

A. I am accepting his testimony as expressing his own opinions.

Q. Did not you say that you believed that he had knowledge of the sewage and a knowledge of the science sufficient to justify you in believing his testimony that he could remove it by the methods prescribed?

1192 A. I did not say by the methods prescribed. I said he could remove it, and of course I mean by the chemical precipitation but, as to applying it in the way he proposes—I very much doubt whether he can accomplish it or not.

Q. I now read to you from page 31 of the testimony, beginning in the last line of Mr. Fuller's testimony:

"By that, I mean to say, that lime and sulphate of alumina, or sulphate of iron might be added to the sewage as it enters the basins. That chemical treatment would promote the clarification in conjunction with the sedimentation resulting from the flow of the sewage to the basins, and in my judgment would bring the removal of total suspended matters from about 60 to 85 per cent and of the total organic matter about 30 to 50 per cent." Do you accept that conclusion of Mr. Fuller's, or do you disagree with him?

A. I accept his conclusion that he can accomplish it by the proper means and plant.

Q. "By that, I mean to say, that lime and sulphate of alumina, or sulphate of iron might be added to the sewage as it enters the basins. That chemical treatment would promote the clarification in conjunction with the sedimentation resulting from the flow of the sewage through the basins, and in my judgment would bring the removal of total suspended matters from about 60 to 85 per cent and of

1193 the total organic matter from about 30 to 50 per cent." Do you accept that?

A. It depends on how he intends to add it to the sewage, and whether he has any other basins for settlement or not.

Q. Then you do not accept it in the way in which it is stated in the transcript?

A. I stated I accepted it conditionally, and I rejected it conditionally. I do not believe he will accomplish the removal of 85 per cent with these basins as they are planned now. I believe if he says he can remove 85 per cent, that he probably can, if he uses the most suitable means for using chemical precipitation.

Q. I am not asking you about something that he does not say. I am asking you whether you agree with this: "By that, I mean to say, that lime and sulphate of alumina, or sulphate of iron might be added to the sewage as it enters these basins." Do you understand what that means?

A. Yes.

Q. "That chemical treatment would promote the clarification in conjunction with the sedimentation resulting from the flow of the sewage through the basins, and in my judgment would bring the removal of total suspended matters from about 60 to 85 per cent." Do you agree with that statement?

A. That statement assumes that he adds no other features and no

other basins, and no other detention tanks than those that exist now.

Q. That is what he says, I think.

A. I do not believe he can accomplish it.

1194 Q. You do not agree with him, in other words?

A. I do not believe he can accomplish it without other features which are not in this question.

Q. Then you do not believe that reliance upon his knowledge of sewage that you testified to a while ago?

A. No; I do not deny it, but I think he can accomplish that.

Q. By chemical precipitation he can accomplish it, can he not?

A. He says so, and I am inclined to give him the benefit of the doubt, as to what he means to use as auxiliary devices to carry out the chemical precipitation to the most efficient degree. I assume he would mean that when he said 85 per cent.

Q. The expression of "benefit of the doubt" is appropriate in criminal proceedings. I am through.

By Dr. O'Sullivan:

Q. Professor Landreth, can 85 per cent of the solids be removed by the plant described in Complainant's Exhbit 135, and by the methods suggested by Mr. Fuller:

A. In my opinion they can not, unless the methods suggested by Mr. Fuller contemplate things which he does not mention in his proposed chemical precipitation.

Dr. O'Sullivan: That is all.

Mr. McCarter: Now, Mr. Commissioner, we have to rebut between the first and the fifteenth of September.

The Commissioner: The matter is now adjourned.

1195 COMPLAINANT'S EXHIBITS.

Mr. Kenneth Allen.

		Offered.	Marked.
No. 219	Population of Manhattan—plotted.....	p. 570	572
" 220	" " Brooklyn "	p. 574	577
" 221	" " Bronx "	p. 577	580
" 222	Diagram—Tidal phenomena	p. 587	589
" 223	Rep. Sew. plans—Upper East River....	p. 591	594
" 224	Land and Sea water—plotted.....	p. 595	597
" 225	Rainfall and Runoff "	p. 595	601
" 226	Float Experiments "	p. 602	609
" 227	Diagram and Curves—Velocities.....	p. 613	615
" 228	" land and sea water.....	p. 619	621
" 229	Borings—plotted	p. 623	624
" 230	Map-harbor depths	p. 627	628
" 231	Map—Oxygen—plotted	p. 709	710
" 232	" " depletion	p. 710	712
" 233	Charts " month to month 1909-1918..	p. 713	714
" 234	Chart of Stanard used for Oxygen.....	p. 715	716

No.	235	Map—Oxygen Minimum—1917	p. 716	717
"	236	Fundamental Assumptions—Sewer design	p. 729	730
"	237	Report—Outlet Sewers—1916 to Mr. Lewis	p. 731	734
"	238	General Plans—main drainage.....	p. 735	737
"	239	Diagram—Sewer plans etc. West 46th St.	p. 738	739
"	240	" " " " " 58th St.	p. 740	741
"	241	" " " " " 80th St.	p. 742	743
"	242	" " " " " 155th St.	p. 744	748
"	243	" Interceptors—Fort Washington.	p. 750	751
"	244	Tables—Dyckman St. Plant—Screens..	p. 753	755
"	245	3 Photographs and Cut " ..	p. 756	756
"	246	Plans—Ward's—Randall's—Riker's Islands	p. 757	759
"	247	Design—interceptors & Sew. treat. E. 49th St.	p. 760	763
"	248	Report—Ocean Island disposal.....	p. 765	766
"	249	Plans—Jamaica Bay "	p. 791	792
"	250	4 Alternate " " project plans.....	p. 794	794
"	251	" " " " " "	p. 795	795
"	252	" " " " " "	p. 796	796
"	253	Photographs—dispersion nozzles P. V. S. project	p. 797	797
"	254	Prof. Phelps—Diagram—Oxygen depletion	p. 909	911
"	255	Sketch Prof. Landreth—Whiple fallacy.	p. 990	1000
"	256	" " " Fuller's 1/8" & 3/4" screen	p. 1015	1017

1196 GEORGE W. FULLER, recalled in rebuttal on behalf of defendants, having been heretofore sworn.

Direct examination.

By Mr. Riker:

Q. You have had submitted to you a transcript of the testimony taken on behalf of the complainants, under the order of March 10, 1919, I believe Mr. Fuller?

A. Yes.

Q. At the bottom of page 1010 and top of page 1011 of the transcript, Professor Landreth, in response to a question submitted to him, says:

"In the works as now being built, the coarse screens stipulated are being provided, but so far as I could learn on inquiry, no grit basins are being provided, and no self-cleansing mechanical screen of any kind whatever are being provided."

Have you examined the works recently?

A. Yes, sir, only yesterday.
Q. Is it true that no grit basins are being provided?
A. It is not true.
Q. Did you see them on your inspection when you examined the works recently?
A. Yes, sir.
1197 Q. What explanation have you for the fact that they were not discovered by Professor Landreth?
A. They are covered up temporarily with a lot of long wooden piles, pending the putting in place of a permanent cover, which will be of steel plates, except for one portion where there is a concrete cover, on which will be placed tracks, rails, on which will move a dredging apparatus of the locomotive type for lifting the sludge deposits and transporting them to a dump for final disposition.
Q. What is the character of the basins being constructed?
A. Well, beyond and down stream toward the pumping station, from the coarse screens there is what is called a bellmouth, which has three fingers or outlets, through which the sewage would flow to the grit basins. These are three in number, about 35 feet long, and each about 16 feet deep, with a width of 15 or 16 feet.
Q. And a depth of about what?
A. A depth of roughly 20 feet, as I recall. Of course that would vary with the depth of sewage in the trunk sewer.

Mr. O'Sullivan: Will you repeat the dimensions?

Witness: 35 feet long; 20 feet ordinary depth, and about 15 or 16 feet wide. These are the dimensions of each of three
1198 separate grit basins.
A. (Continuing:) Then from these grit basins there is a continuance of each of those three waterways into the screen house where are located the other screens.
Q. Have you recently seen the plan which involves this part of the works?
A. Yes.
Q. Have you a copy of it with you?
A. Yes.
Q. Will you produce it and identify it and state where you got it, from whom you got it and what marks it carries to identify it?
A. I produce sheet 4 of contract No. 41, bearing the title: "State of New Jersey Passaic Valley Sewerage Commissioners Newark Bay Pumping Station. Foundations and Connection. Grit Chambers & Screen House." It is dated January 30, 1914, and marked "Acc. No. B1754" in the lower right-hand corner. It is signed by Wm. M. Brown, Chief Engineer, and by Wm. Gaven Taylor, Principal Assistant Engineer.
Q. Do you know their signatures?
A. I do; they are genuine signatures. I might explain that the words "Grit Chamber" as shown on these drawings and the
1199 expression "grit basins," as I have probably used in an earlier answer, are exactly synonymous terms, and refer to the same thing.

CONTRACT No. 41 – SHEET 4.

SHEETS IN SET, 19.

New York)
v. ; No. 3, Original
New Jersey)

Defendants Exhibit No. 10.
James D. Mahon
Commissioner.
(Page 1199-a)

Section on E-F

Section on G-H

State of New Jersey

PASSAIC VALLEY SEWERAGE COMMISSIONERS

NEWARK BAY PUMPING STATION

FOUNDATIONS AND CONNECTIONS

Q. The plan which you produce is a blue print, I observe?
A. Yes.

Mr. Riker: I offer this plan in evidence and ask that it be numbered the next serial number in the defendants' exhibits.
Commissioner Maher: It will be received in evidence.

(Marked Defendants' Exhibit No. 10.)

(Here follows diagram marked page 1199*a*.)

Cross-examination.

By Dr. O'Sullivan:

Q. Do you know who made the drawing that you are presenting now as the exhibit, Mr. Fuller?

A. I am not personally acquainted with its antecedents prior to its having been given to me by Messrs. Brown and Taylor. I assume, of course, it was made in the drafting room of the Passaic Valley Commission.

Q. Did you have anything to do, Mr. Fuller with the preparation of this drawing?

A. No.

Q. Did you make any comparison between this drawing that you are now presenting and the original drawings of the plan and
1200 specifications as made in 1914?

A. I looked into the question of what velocities of flow would be obtained, but not recently. I did that some months ago. I made no actual taping of dimensions. I am now making a general statement that from observation the structures are built substantially of the dimensions shown.

Q. Did you see grit chambers as depicted in this piece of draftsmanship which you are now offering?

A. Yes.

Q. How did you happen to see them; did they remove these pilings and other matters that hid them from your view?

A. I looked down between these pilings; these pilings are not perfectly straight and there are quite sizable openings, so that one can get an opportunity to look down. I took particular pains to look at the inlet end where the sewage enters these grit chambers.

Q. And the dimensions that you are giving, and that are given here in this drawing, of the sizes of these grit chambers, how did you verify these?

A. Just by inspection. As I say, I made no attempt to measure them. It was told to me by Mr. Brown and Mr. Taylor that they were built as shown on these plans, and I haven't the slightest
1201 hesitancy to say that is substantially true from my own inspection on the ground. I may add this, with respect to vertical dimensions, it is possible to see down to the bottom—substantially at the bottom of these grit chambers or grit basins.

Q. How large an opening were you looking through?

A. I imagine that the space between some two of these piles might be eight or ten inches.

Dr. O'Sullivan: The exhibit is objected to as not being properly authenticated and not disclosing any facts actually within the knowledge of this witness.

Commissioner Maher: Note the objection of counsel for complainants.

Further Direct examination.

By Mr. Riker:

Q. You have already been asked, Mr. Fuller, by Dr. O'Sullivan, with reference to the actual grit chambers as they are constructed conforming to this plan. Do they conform, so far as you are able to judge from your examination of them?

Q. Yes, and the over-all dimensions are very readily noticeable on the ground; that is, the width of these three grit chambers, side by side, is thoroughly noticeable; the outside walls are up to their full permanent elevation. With regard to the dimension
1202 parallel with the direction of flow, that is also plainly discernible. What I want to make plain is, that over the top there is built this roofing, on which, it is noted here, there will be a standard gauge track, 90 pound rails. That is built there, but the openings between that central portion of the cover and the inlet and outlet ends, that has not been built. It is also possible to look down and see the approximate location of the bottom.

Q. Referring again to Prof. Landreth's testimony at the foot of page 1010 and top of page 1011 of the transcript, I direct your attention to the statement, "And no self-cleansing mechanical screens of any kind whatever are being provided." Is that true?

A. There are no self-cleansing screens being provided?

Q. Are there any fine screens being provided?

A. Yes.

Q. How many sets of screens, in fact, are being provided in this construction?

A. At the inlet to the grit chamber there are coarse screens, and then beyond the grit chamber, toward the pumping station, in the screen house, there are wo sets of fine screens in each of the three waterways leading from each respective grit chamber on into
1203 the pumping station, so there are two sets.

Q. On page 1017 of the transcript, Prof. Landreth says, middle of the page:

"I did not see a place where any could be placed, and I traced the flow of sewage at all points which were accessible to me on that day from the point of entrance from the channel, to the point of leaving the *endentention* basins, and I did not discover any place where other screens could be placed." Did you make an examination to determine whether there were provisions made for two sets of screens?

A. Yes.

Q. And you have indicated in general by reference to this plan, the points at which provision was made for them?

A. Yes. The plans show clearly a screen located, as I have already said, above the grit chamber, and then in the screen house there are the three waterways, in each of which waterways are cast-iron screen grooves shown and designated on the drawing.

Q. Referring to the first location that you have mentioned, did

you make an examination of the actual construction to see whether a provision was made for the screen at that point?

A. Yes, I looked down through the openings and found at the inlet to the grit chamber there are two grooves for stop planks, and then in front of those stop plank grooves is a place left to which will be attached the bars going to make up the coarse screens.

1204 Q. Are the screens themselves actually in place?

A. No, none of the screens are in place.

Q. Now, the location for the second set of screens to which you have referred, did you see whether or not actual provision was already made for the reception of these screens?

A. Yes, the grooves are there for two sets of screens in each of the three channels.

Q. How many openings are provided for screens at that point?

A. There will be six different screens, and there are three water ways or channels, and makes six in all.

Q. Have you a plan of the screens as proposed?

A. I saw the contract plans dated January 1918 and I also have a sketch showing the spacing of the bars to indicate the distance between the bars which will make up the six individual fine screens which I have testified about.

Q. Will you give the identification marks of this last plan that you have produced?

A. This carries the title, "State of New Jersey. Passaic Valley Sewerage Commissioner. Newark Bay Pumping Station. Screen. Screen Bar Spacing in Cage Screens." It is dated Septem-

1205 ber 2, 1919. It carries in the lower righthand corner Accession No. L3090. It consists of a sketch indicating, as its title shows, the spacing of the bars as originally projected on the contract drawings.

Q. Who furnished you this sketch?

A. Messrs. Brown and Taylor gave it to me.

Mr. Riker: I offer this sketch in evidence and ask that it be marked Defendants Exhibit No. 11.

Commissioner Maher: The exhibit will be received and marked as requested by counsel for defendants.

Cross-examination.

By Dr. O'Sullivan:

Q. Do you prepare this sketch yourself, Mr. Fuller?

A. No, I did not.

Q. Did you compare it with any original plans or drawings that are in the custody of the Passaic Valley Sewerage Commissioners engineers?

A. Yes, I did compare it with a corresponding earlier sketch which I was given last spring, and I also compared it with the contract plans. I looked into it with some care, because I found that in looking over the transcript of my testimony in June, I

1206 had misstated one of the dimensions.

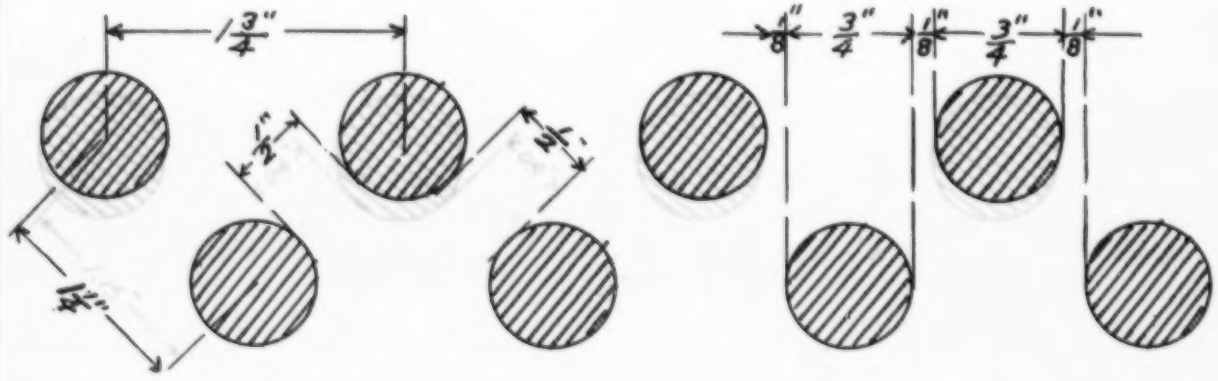
State of New Jersey

Passaic Valley Sewerage Commissioners

NEWARK BAY PUMPING STATION

SCREEN BAR SPACING IN CAGE SCREENS

SEPT. 2, 1919.



Direction of Sewage flow

New York,)
v. : No. 3, Original
New Jersey)

Defendants Exhibit No. 11.

James D. Maher
Commissioner.

(page 1207-a)

Scale:- Full size

Acc. No. L 3090

Q. Which of the dimensions?

A. The space between the rods I stated in June as three-quarters of an inch; it is actually one-half inch. I was then speaking from memory, and must have either confused it with the diameter of the rod or with some of the designs in my office that are now going on as to similar arrangements.

Q. There is a marking here of three-quarters of an inch between bars; I would ask what that means in this sketch?

A. I think that means the diameter of the rods. The spacing between the roads is shown in white here as one-half inch, and there is also in yellow a different spacing, namely, four-tenths of an inch. The three-quarters of an inch does not show. That is my mistake in my June testimony.

Q. Does this sketch represent anything that is now in existence?

A. No, that is not in existence.

Q. On what do you base any claim for accuracy of this sketch?

A. Leaving out of view those yellow markings, that is a correct sketch showing the spacing of the bars in the screens on con-
1207 tract drawing which bear the date of January, 1918, and of which I was furnished a copy.

Q. In other words, this corresponds with some other drawing which was shown you by the engineers of the Passaic Valley Sewerage Commissioners?

A. That is right, and on which they took bids in 1918.

Dr. O'Sullivan: This sketch is objected to on the ground that it does not represent anything in esse, and that it is not properly proven or authenticated by this witness, and as not representing any matter within the witness's actual knowledge.

Commissioner Maher: Note the objection of counsel for complainants.

(Marked Defendants' Exhibit No. 11).

(Here follows drawing marked page 1207*a*.)

Further Direct examination.

By Mr. Riker:

Q. Your testimony given in June, Mr. Fuller, related in part, did it not, to the proposed construction of the fine screens?

A. Yes, sir.

Q. And this is the plan to which that testimony refers, is it not?

A. Yes.

Q. But you were in error in giving your dimension of the spacing between the rods, in your earlier testimony?

A. Yes.

1208 Q. The distance between the rods being one-half an inch instead of three-quarters of an inch as testified by you?

A. Yes.

Q. You are familiar with the stipulation between the United States and Passaic Valley Sewerage Commissioners, which is complainants' exhibit No. 135 in this case, I believe?

A. Yes.

Q. In what respect, if any, does the structure as already built and the plans for the screens as proposed, differ from the device and structure as described in the stipulation?

A. In the first instance, the screen proposed is what is called a semi-fixed cage type of screen and not a self-cleansing mechanical screen. In the second instance, the stipulated openings are to be four-tenths of an inch. On the sketch, Defendants' Exhibit No. 11, the blue print figures show one-half inch; but also I call attention to the fact that on the same sketch there are shown in yellow ink an arrangement of the rods which would bring that space between them to four-tenths of an inch, as mentioned in the stipulations. That dimension, I understand, of four-tenths of an inch, it is perfectly feasible to adopt. I was so informed by Messrs. Brown and

1209 Taylor.

Q. Without any considerable increase in costs in the construction—in the cost of the screens?

A. None whatever. The number of rods in each screen would be the same. It is simply a question of changing the spacing.

Q. Do you know whether the change of the character of the screen has received the approval of the War Department?

A. Yes, it has.

Q. Have you seen the original approval of the change?

A. Yes.

Q. Have you a copy of it here?

A. I have. (Producing same.)

Q. Have you compared that with the original?

A. Yes.

Q. Is it a copy of the original?

A. Yes, sir.

Q. What marks were on the paper submitted to you as to the original which satisfied you that it was what it purported to be?

A. The stationery carried the water mark of the United States

seal. It had the Government stationery heading "War Department, Washington." It was signed by the Acting Secretary of War. It was initialed by Wm. T. R., who was the District Army En-
1210 gineer in New York at that time, and it also carries in ink the official folio number 20103, followed by the letters "Engrs." That is the Engineer Corps file number. I am satisfied it is an original document.

Mr. Riker: I offer a copy of the document in evidence and ask that it be marked Defendants' Exhibit No. 12.

Commissioner Maher: The exhibit will be received and marked as requested by counsel for defendants.

Cross-examination.

By Dr. O'Sullivan:

Q. When did you first see this paper dated September 13, 1913, Mr. Fuller?

A. It was during the first week in April of this year when I first visited Newark Bay Pumping Station and looked into the plans in the engineer's office of the Passaic Valley Sewerage Commissioners.

Q. And you read this paper as an approval of the altered plans for screens adopted by the Passaic Valley Sewerage Commissioners?

A. Yes.

Q. How do you interpret this third paragraph:

"You are informed therefore that the War Department will interpose no objection to the substitution"——

Do you infer from that an approval of the plans and of the
1211 substitution?

A. I call that an approval, yes; it also speaks of these not being less efficient than those originally proposed in the stipulation.

Q. You understand that this promises no objection or interposition to the substitution of one set of screens for the two sets of screens originally prescribed by the Passaic Valley Sewerage Commissioners?

A. No, that isn't my idea at all. There will be two sets of screens, and this approval by the War Department refers to a modification slightly in type of the second or fine screens.

Q. Are there any dimensions given here in this paper purporting to be issued by the War Department, as to the size of the screens?

A. Not that I recall.

Q. Do you know whether or not, Mr. Fuller, this paper was issued by the War Department in reply to any paper that was sent to the War Department by the Passaic Valley Sewerage Commissioners?

A. It states there the communications of certain dates earlier in that year.

Q. Did you see those letters?

A. No, I asked about them and asked about the screen spacing then under consideration and was given a copy of a sketch
1212 showing the same dimensions as those of Defendants' Exhibit No. 11.

Q. Do you know whether or not a copy of Defendants' Exhibit No. 11 was sent with the communication to the War Department?

A. No, not of that date, but of a similar one dated March 22, 1913, I was informed was sent to them.

Q. Who informed you of that?

A. Either Mr. Taylor or Mr. Brown.

Q. And in none of those communications are actual dimensions given of the size of the screen, are there?

A. I think it is not given in that letter signed by the Secretary of War, but I am quite positive that that is set out in the communications addressed to the War Department, and to which that is a reply.

Q. And you are positive of that fact, although you never saw these communications?

A. I have the accompanying sketch showing the lay-out of the screens, which I was given last April and which, as I say, bears the date of March 22, 1913.

Q. How does that sketch differ from the sketch that has been put in evidence by you as Defendants' Exhibit No. 11?

A. So far as the blue print dimension is concerned, they are identical; the date is different; the accession number is L1507,
1213 and the 1913 of the accession number 1507 shows no yellow ink markings with a change of spacing.

Dr. O'Sullivan: This paper is objected to as not representing any matter distinctly within the knowledge of this witness and as not proof of anything definitely that has been submitted to the War Department.

Commissioner Maher: Note the objection of counsel for complainant.

(Marked Defendants' Exhibit No. 12.)

"20103 Eng'rs. Wm. T. T.

Copy.

War Department,

Washington.

September 12, 1913.

Mr. Francis Child,
Chairman, Passaic Valley Sewerage Commissioners,
31 Clinton Street, Newark, N. J.

SIR:

1. Your letters dated April 8 and May 6, 1913, addressed to the district engineer officer, Army Building, New York City, in which you request in behalf of the Passaic Valley Sewerage Commissioners, that semi-fixed cage-screens as described therein be substituted for the continuous link belt type of moving screens stipulated by War Department permit dated May 11, 1910, authorizing the location of a sewer outlet in the vicinity of Robbins Reef Light, have been received by the Department.

2810 3 Engrs.

New York
New Jersey } No. 3. Original
Defendants Exhibit No. 12
James J. Maher
Commissioner

COPY.

WAR DEPARTMENT

WASHINGTON. September 15, 1913.

Mr. Francis Child,
Chairman, Passaic Valley Sewerage Commissioners,
31 Clinton Street, Newark, N. J.

Sir:-

1. Your letters dated April 8 and May 6, 1913, addressed to the district engineer officer, Army Building, New York City, in which you request in behalf of the Passaic Valley Sewerage Commissioners, that semi-fixed cage-screens as described therein be substituted for the continuous link belt type of moving screens stipulated by War Department permit dated May 11, 1910, authorizing the location of a sewer outlet in the vicinity of Robbins Reef Light, have been received by the Department.

2. The district engineer officer in transmitting the above-mentioned letters and their accompanying plans, states that he has examined the proposed type of screens at Deer Island and Hough's Neck, Boston Harbor, Mass., and expressed the opinion that these screens would not be less effective than the continuous link belt type of moving screens.

3. You are informed therefore that the War Department will interpose no objection to the substitution of the semi-fixed cage-screens for the continuous link belt type of moving screens for the sewer outlet in New York Bay in the vicinity of Robbins Reef Light.

Very respectfully,

(SIGNED) Henry Breckinridge,

Acting Secretary of War.

(Page 1228-a)

2. The district engineer officer in transmitting the above mentioned letters and their accompanying plans, states that he has examined the proposed type of screens at Deer Island and Hough's Neck, Boston Harbor, Mass., and expressed the opinion that
1214 these screens would not be less effective than the continuous link belt type of moving screens.

3. You are informed therefore that the War Department will interpose no objection to the substitution of the semi-fixed cage-screens for the continuous link belt type of moving screens for the sewer outlet in New York Bay in the vicinity of Robbins Reef Light.

Very respectfully,
(Signed) HENRY BRECKINRIDGE,
Acting Secretary of War."

Further direct examination.

By Mr. Riker:

Q. Again reading from the transcript of the testimony of Prof. Landreth, at the bottom of page 1010, I find the following:

"In the works as now being built, the coarse screens stipulated are being provided, but so far as I could learn on inquiry, no grit basins are being provided, and no self-cleansing mechanical screens of any kind whatever are being provided."

Continuing:

"This is a very distinct deviation and an exceedingly important omission from the features demanded in the stipulations. Those stipulations distinctly call for two entirely different screens having very different functions; the first or coarse screen to remove large floating matter, the second or self-cleansing mechanical fine screen to remove the finer suspended particles of sewage. The coarser screen is being supplied as stipulated; the finer screen is not being furnished at all."

Is that a correct statement of the situation, Mr. Fuller?
A. No.
Q. In just what specific features do the works as constructed and as indicated by contract drawings differ from the stipulation?
1215 A. They differ only in regard to the type of fine screen; that is, it is the semi-fixed cage-screen type rather than the self-cleansing mechanical screen; there is also this element of spacing that I have already described at length—five-tenths as against four-tenths of an inch.
Q. Is the coarse screen provided for?
A. It is.
Q. Are the grit chambers provided for?
A. Yes.
Q. Are the fine screens provided for?
A. Yes.

Q. And it is in the features of the above screens that the variation occurs?

A. It is.

Q. And those are the ones that are covered by Defendants' Exhibit No. 12, the approval of the War Department?

A. Yes.

Q. As indicated by the contract drawing, the deviation in the fine screen involves a spacing between the rods which will leave apertures of a half inch instead of four-tenths of an inch?

A. Yes, that is measured not at right angles to the direction of flow, but that is the distance from rod to rod.

Q. And the omission of the self-cleansing feature of it, is
1216 that also a feature that is involved in the stipulation?

A. Yes.

Q. Where is the type of screen that is described in the stipulation actually in use, if you know?

A. In Boston, Washington, Baltimore and other places.

Q. In the stipulation I speak of?

A. In the stipulation; it is in use at Hamburg, although the stipulation does not set out as explicitly the so-called link-belt type of moving screens, as is mentioned in the certificate of approval of the War Department, and as I happen to know, was discussed in earlier years. There is nothing in the stipulation itself that would suggest a limitation to the Hamburg type of screen.

Q. Now, Mr. Fuller, are the deviations which appear in the contract drawings and in the construction of the works indicated in the stipulation exceedingly important omissions?

A. No.

Q. Why not?

A. Because that would not lessen the efficiency of the screens appreciably in removal of suspended matters.

Q. What effect, in your judgment, will the omission of the
1217 self-cleansing feature of the screen have?

A. That makes for a more convenient operation, but the self-cleansing feature of a screen does not make for a greater increase in efficiency in the removal of suspended matters. On the contrary, the cleaning coming intermittently is conducive to an increase in the retention of sewage solids.

Q. I read from the testimony of Prof. Landreth as appears in the transcript, at the bottom of page 1013 and top of page 1014:

"I wish to say in explanation of my term 'stationary type', that I mean that while the screen is in operation, it is fixed and stationary."

Will that be true of the screen as now proposed by the modifications?

A. Yes.

Q. Continuing:

"I do not mean it could not be removed, to have its particles cleaned out. That is the case. It may be taken out, but while

it is taken out, another screen is in its place so that the screening function is not interrupted. By the word 'stationary,' therefore, I refer to the condition of the screen, while it is functioning. In the self-cleansing mechanical screen, the screen is in motion all the time either by one device or another, and being in motion it acquires the capacity to remove a much larger proportion of the solid and much smaller particles, than is the case of a fixed screen against which the particles may float, and be ultimately pushed through, or washed through before they are removed."

Is that a true statement of what occurs?

1218 A. No, it is not.

Q. What is your opinion as to the relative effectiveness of the stationary screen as compared with self-cleansing mechanical screen?

A. The stationary screen is more efficient in removing solids; owing to the accumulation between the cleaning intervals or solids on these rods, the increasing accumulation, there comes a corresponding diminution in the available waterway between the rods and the materials attached to them. That goes to make a finer screen, after the screen becomes clogged, than is the case when the screen is clean.

Q. Now, referring to Defendants' Exhibit No. 11, I understand you to say that the spacing of the rods constituting the mesh of the screen could be readily and without any appreciable increase in cost made so that the distance between them—the greatest distance between the tangential lines would be four-tenths of an inch instead of a half?

A. Yes.

Q. If that is done, will the screen in that respect conform to the stipulation?

A. Yes, as regards spacing.

Q. In your opinion, Mr. Fuller, are the deviations from the stipulation indicated by the works as being constructed and as
1219 shown by the contract drawings, important omissions from the features demanded in the stipulation?

A. No.

Q. How will the result in the clarification of the sewage compare in the two cases?

A. I don't think it will be detected.

Q. In your direct testimony in June, Mr. Fuller, you told that additional arrangements might be introduced into the Passaic Valley works which should be likely to result in greater efficiency. You remember that, do you not?

A. Yes.

Q. Referring now to the testimony introduced in answer to the testimony of the defendants under the order of March 10, 1919, at page 1022 of the transcript I read as follows:

"Mr. Fuller proposes, on page 25, and again refers to it on page 75, to maintain the same period of detention in the sedimentation basins and to reduce the distance passed through by the sewage, to one-third its original planned distance, thus to obtain a velocity of one-third of the original resulting velocity. If that arrangement

can be produced, it will be beneficial, but Mr. Fuller proposes to introduce it into the present sedimentation basins, and moderate alterations, by dividing up the whole distance of, as he says, 216 feet; dividing that into three portions, so that one-third of the sewage should pass over the first third of that distance; another third of the sewage should pass over the second third; that
1220 is to say, should enter the basin at the end of the first third, and leave it at the end of the second third; and the remaining one-third of the sewage should enter at the second third, and leave it at the end of the third third; and I repeat that in my opinion if that could be done in the present basins, it would accomplish some probable improvements in the results of sedimentation, but Mr. Fuller proposes to do so without rebuilding the exterior walls of the sedimentation basins, and apparently without any great or material alteration of the construction of the basins. I judge that from his statement, and also from his estimate on cost. He considers that he would be able to introduce sewage at these two new points, namely, at the end of the first one-third of the length, and again at another place, at the end of the second one-third of the length, and also take out the portions which end there, namely, take out the sewage which ends at the end of the first one-third, and put in a new portion of sewage, which shall flow on through the second one-third; and there, again, to take out that portion of the sewage and introduce the new remaining one-third at that point, and let that flow through the latter portion.

"Now, those nine spaces into which the total length of flow is divided, forming nine hoppers, are each 24 or 25 feet in width, and come right together. There is no margin or distance between them. One joins the other. There is, therefore, no room for the very spacious necessary inlet and outlet connections for those portions of sewage in that space, without doing either one of two things: either without encroaching on the total distance, and thus cutting down the total line of travel to less than one-third in each case, or else to introduce the sewage at considerable velocity in small pipes, and thus to introduce the very harmful element of agitation and high velocity on entering the one-third portions."

Is that a correct statement of your view in regard to the feasibility of this proposed change?

A. No.

Q. Why not?

A. Because it is feasible to do what I said in June and at
1221 the cost that I there set forth.

Q. How will that be accomplished, Mr. Fuller?

A. It will be accomplished by building an effluent channel about one-third of the distance lengthwise of each of these four basins, and it would be necessary also at the two-thirds distant point along the length of each basin to build an influent conduit. Then, as has been stated in the testimony, one-third of the flow of the sewage would go through the inlet, as would normally be the case, and instead of meeting some 70 feet distant simply a baffle as is now being built, it would meet a new effluent conduit, and there spill over weirs, and there would have to be an opening from that conduit

to the main effluent conduit. At a point about 150 feet from the inlet two-thirds of the amount of sewage settled in the tank—treated in the tank—would go into a new influent conduit. That would be similarly arranged to the conduit at the main inlet; it would have two sets of sluice gates; through one set of sluice gates the sewage would move in the direction toward the inlet and go into the effluent channel toward the inlet and go into the effluent channel which I have just spoken of. In speaking of that effluent channel, I spoke of the size. It would take two-thirds of the total sewage treated in the basin as it now stands.

1222 Coming back now the influent conduit, the other set of sluice gates would allow one-third of the volume of sewage to move towards the original effluent conduit, so that in each of those four sets of tanks it will be necessary to install two conduit walls in place of the baffle walls or dividing walls, and making one a double effluent channel, and the other a double influent channel.

There is one other feature, the connections which must lead into the waterways. It is a fact that on the further set of tanks, of which there are four, the two next to Newark Bay would require an influent conduit to be extended about 150 feet or so from the present influent conduit down to the double influent conduit leading across—transversely across the basins themselves.

Q. You have examined the basins as they are being constructed?

A. Yes.

Q. How do they compare with the basins required by the stipulation which is Complainants' Exhibit No. 135?

A. They are in excess of the capacity called for in the stipulation.

Q. When you say "in excess," in what respect do you mean?

A. By volume and cubical contents. It is possible with
1223 the basins as they stand today, or when they are completed in a few weeks from now, to get velocities lower than set forth in the stipulation. My answer to your recent question deals solely with my proposal of June to cut down the velocity one-third below that set forth in the stipulation.

Q. I now ask you whether the introduction of this new dividing wall or partition will cut down the total length of the detention basins below the total length stipulated in Complainants' Exhibit No. 135?

A. No. I think they will be substantially of the dimensions stated in the stipulation and shown in the original drawing. Of course, there is the thickness of these walls to be taken into account; they are a little wider division walls than shown at the present time.

Q. Does your plan as suggested contemplate the reconstruction of the hoppers which are at the bottom of the sedimentation basins?

A. No, not at all. This new work is above them and it will simply be necessary to key the bottom of the new channels on to the top of these hoppers, which will not be disturbed as working arrangements for removal of sludge, not in any measure.

Q. Will it be necessary to reconstruct the connections which lead to and from the hoppers, under your plan?

1224 A. Not at all.

Q. Prof. Landreth in his testimony above referred to,

which appears at page 1024 of the transcript, about the middle of the page, says:

"It is quite possible that he might do that under the limited expense which he refers to, but if he does, he will both cut down the distance traveled through, somewhat, and he will introduce what is more harmful by his high pressure pipes and high velocity."

Is that correct?

A. No.

Q. Why?

A. There are several factors that bear on that proposition. In the first instance, these conduits at the present inlets will be left entirely alone, and through each of those sluice gates there will be about only one-third of the volume of sewage as now originally proposed. That holds true for the new influent conduit. It is not at all necessary to have any outside piping attachments in any way. If it would be desired to check the entering velocity, it is perfectly feasible to put a baffle or board in front of the opening, say a foot or so in front of it, and that would stop the entering velocity and the direct travel toward the effluent channel. I mean by that, that the entering sewage, with a board in front of the sluice gate, would have its sewage flow deflected, part to the other side of that baffle
1225 board, and part above and part below. In other words, it is possible to check that velocity, as is frequently done in practice.

Q. The putting into actual operation of the plan which you suggested in reference to the basins will reduce the sedimentation capacity of the existing tanks to some extent?

A. These thicker walls will make a reduction of two or three per cent in the content of the tanks.

Q. As they are constructed?

A. As being constructed, but they will still have a content in excess of that set forth in the stipulation.

Q. I observe that you are using the blue print in connection with your testimony. Will you state the describing marks on this blue print?

A. This blue print is the sheet No. 5, Contract No. 58, carrying the title "State of New Jersey. Passaic Valley Sewerage Commissioners. Outfall Sewerage Works. Sedimentation Basins. Contract Drawings—Part of Section 4. General Cross Sections." It is dated April 15, 1915. It bears Accession No. B 2135. It is signed by Wm. M. Brown, Chief Engineer, and Wm. Gaven Taylor, Principal Assistant Engineer. On this drawing I should state that there is shown in yellow pencil an arrangement of the effluent
1226 channel which I have described, and also a new dividing wall, in the bottom of which would be an influent conduit, to allow the purposes to be served, as I have described.

Q. Who placed the part of the plan which you have last referred to, in yellow, on the plan?

A. It was placed there, under my direction, by Mr. Elmer G. Manahan, who has charge of my drafting room.

Q. Did you identify the signatures of Mr. Brown?

CHART

TOO

LARGE

FOR

FILMING

A. Yes, I spoke of them; I know they are correct.

Mr. Riker: I offer this blue print in evidence and ask that it be marked Defendants' Exhibit No. 13.

Commissioner Maher: The exhibit will be received and marked Defendants' Exhibit No. 13.

Cross-examination.

By Dr. O'Sullivan:

Q. Mr. Fuller, in the drawing which you have just produced and which has been offered in evidence, who did you say put these yellow letterings and figures on the blue print?

A. Mr. Elmer G. Manahan.

Q. And what do they represent?

A. They represent the modification in influent and effluent arrangements and constitute the entire apportion of new work that will be involved within these basins now building, in order
1227 to bring about the reduction in velocity which I testified to in June.

Q. Have you submitted these modifications or alterations to the chief engineer of the Passaic Valley Sewerage Commissioners?

A. I have discussed them with him several times.

Q. Have you shown him this drawing with these yellow markings on?

A. I think I showed him the computation sheet, which showed the same arrangement. There are different ways in which that can be done with the same—with substantially the same amount of cost.

Q. When did you show that to Mr. Brown, the chief engineer of the Passaic Valley Sewerage Commissioners?

A. A week ago today.

Q. What effort have you made to determine the accuracy of the original drawings on which these yellow markings are superimposed?

A. I inspected the basins as being built last spring; I discussed the matter with Messrs. Brown and Taylor in May. I am absolutely convinced that the basins are being built substantially as shown on that blue print. I didn't verify them with a tape. I am further convinced from my inspection yesterday. I looked over these basins carefully on the ground as they are now being built.

1228 Dr. O'Sullivan: The offer is objected to on the ground that it does not represent any facts within this witness's knowledge, or whether or not these alterations and modifications are feasible in connection with the plans upon which they are superimposed.

Commissioner Maher: Note the objection of counsel for complainant.

(Blue-print referred to marked Defendants' Exhibit No. 13.)

(Here follow fac-simile letter and plans marked page 1228*a*.)

Further direct examination.

By Mr. Riker:

Q. In your testimony in June, Mr. Fuller, you suggested a second additional arrangement to increase the efficiency of the plan of the Passaic Valley Sewerage Commissioners, consisting of fine screens to be installed after the sewage has passed through the sedimentation basins. At page 1028 of the testimony in this case, appears the testimony of Prof. Landreth with reference to the proposal as contained in your testimony; have you read that testimony?

A. Yes.

Q. At the bottom of page 1028, I read:

"These fine screens would not intercept this gas liquid sludge, unless they were exceedingly fine, because that material is
1229 exceedingly fine; and while it comes up sometimes in large flakes or cakes, it is so easily broken up that a hose of water or the spraying of water will separate it and break it up into its constituent granules or portions. Consequently, a screen to intercept that must be fine enough not to intercept the whole cake or flake, or haul back, but to intercept the individual units of which that is made. Now, if it is fine enough to do that, it would also intercept a large portion of the solids which are going down, for the first time, and would take out of the sewage therefore, some, and perhaps a larger part, while it is in operation, of the highly objectionable material; but that would require mechanical ways for operating those screens, and handling a large amount of material accumulating on those screens. Moreover, that is an emergency measure only for hot weather. He does not propose it continuously." Is that a correct statement of the effect of the conduct and operation of these screens?

A. Yes. I intended in my proposal to use them, if need be, and that necessity would be associated directly with the gas lifting of the sludge already deposited in the basins.

Q. Are such screens as you have testified to in actual operation in any place?

A. Yes, I have had quite a little experience with them, both revolving screens, so-called self-cleansing screens, and also stationary screens.

Q. Will you state that experience?

A. The first experience was at Columbus, Ohio, where they had sedimentation tanks in which the sludge was allowed to accumulate for some weeks and months. Gas evolution will lift sludge
1230 during warm weather to the surface, so that in the effluent leaving the tanks on its way to the sprinkling filters there was a sufficient amount of suspended matter to become seriously bothersome through clogging of the springling nozzles or jets, which are some ten or twelve feet apart over the entire ten acres of sprinkling filters. It is found that by putting screens, as I recall, one-eighth of an inch mesh—that is, a mesh screen with eight openings per lineal inch—that that really was quite a material help.

At Atlanta my firm built sewage disposal works for three different plants comprising two story sedimentation tanks and sprinkling filters. We put in fine revolving screens—I think mesh screen with openings twenty-four in number per lineal inch. In that plant gas-lifted sludge did not find its way to the outlet. There were between thirty and fifty thousand people hitched onto the sewer system leading to the Proctor Creek plant, and during the first year and a half the fine screen did not take out more than a wheelbarrow load and a half of screenings.

On the other hand, at Baltimore, where there are single story tanks, the sludge is lifted during warm weather by gas ebullition. They had trouble as at Columbus. They installed a re-
1231 volving screen also, I think with twenty-four openings per lineal inch, and they corrected materially the clogging of the sprinkling nozzle. Where formerly five or six men were required to keep free the nozzle over ten acres of stone filters, one man, after the installation of the screens to treat the effluent of the sedimentation tanks, could clean the nozzles.

At Schenectady, they had tanks with a sort of interior wall, but there is sometimes trouble with solids leaving the tanks, as the sewage moves toward the sprinkling filters. There they have installed fine screens that are stationary and cleaned from time to time. So that, generally speaking, taking into account this experience that I have outlined, and some others, I will say that there are occasions, at some plants frequent occasions, at other plants no occasion at all, where gas ebullition does make it important to consider the retention of gas-lifted sludge. These fine screens that I proposed in June are not any arrangements for continuous use. They are strictly in relation to the emergency which may or may not ever arise. It will arise only in the event that the solids, that is, the sludge deposited in the hoppers of these tanks, is not
1232 taken out with sufficient frequency to prevent putrefaction to proceed to a point where gas evolution will lift the solids into the flowing stream and into the outlet channel.

Q. Then the emergency to which you refer is when the actual operation of the plant develops that gas-lifted sludge does appear in the effluent from the sedimentation basins?

A. Yes; that is, in the event that that should be an experience, I proposed a remedy.

Q. And your remedy is a preventive remedy in case that occurs?

A. Yes.

Q. In your testimony last June you proposed a further arrangement for increasing the efficiency of the Passaic Valley sewerage plant, consisting of the introduction of air into the intercepter. You have read the transcript of the testimony of Prof. Landreth appearing at page 1030?

A. Yes.

Q. I draw your attention to the following criticism made by Prof. Landreth of this proposal submitted by you—I am reading from the fifth line from the bottom of page 1030:

"In the first place, the first effect of blowing in air would
1233 be to create a large volume of noxious odors. We cannot put air into a tunnel without taking some air out of the tunnel. If you put it in under compression, it will come out under expansion. If not compressed below its natural atmospheric volume, when it comes out it will be loaded with these noxious odors, so that any point along the tunnel where he proposes to introduce this air, he must have some means of escape or ventilation for the air which escapes from the compressed air of the pipes through the bubbles of sewage, which will bring away a great burden of odors."

Is that a correct statement, Mr. Fuller?

A. Not from the view point which I had in mind as to location for applying the air.

Q. Will you state that viewpoint?

A. I had in mind, and do now have in mind, the application of air at a point sufficiently high up on the trunk sewer to find sewage which has not reached the putrefying stage, and from which dissolved oxygen has not been withdrawn by bacterial decomposition. So that the Professor did not understand, or I didn't make clear my viewpoint in June. It is to put in air sufficiently high up along the line of the trunk sewer to guard against that very condition which the Professor speaks of. I mentioned the Paterson and Passaic line as the point of application—that was done in an illustrative sort of way. It should come up two or three miles above that, if that is necessary. As I look at it, at some long distant period into the future, if the oxygen should be exhausted at the Paterson line,
1234 I want to make it very plain that I propose to put in air sufficiently far up along the route of the trunk sewer, so it will reach the trunk sewer prior to the exhaustion of oxygen and prior to the sewage reaching an offensive condition.

Q. He says on page 1021:

"In the second place, he cannot reach the real source of the odors which are in the great number of small particles, until he has first converted into a harmless condition or state the liquid which forms their vehicle and which bears them along. That is only carried out by oxydization, and he cannot preserve the solids against putrefactive odors, until he oxydizes the liquid medium in which those particles are being suspended and carried along."

Is that true?

A. No.

Q. Why not?

A. Because it is not necessary to oxidize a liquid. It is my view to maintain oxygen throughout the entire body of the liquid, so that these bacteria present in decomposing the sewage will do it at all times in the presence of oxygen, rather than do it in the absence of oxygen.

Q. Is it a fact that the beneficial effect of dissolved oxygen is that it oxidizes the matter carrying it?

A. I understand that question to be directed to the proposition of

whether the oxygen in the air will directly oxidize the organic
1235 matter, or whether they will do it indirectly through the aid of bacteria. I am clearly of the opinion that the oxygen of the air will bring about a merely nominal amount of direct oxidation, and that the great bulk of the change brought about by the presence of oxygen is due to keeping the bacteria going on this aerobic basis. I speak now having in mind a sewage polluted water can be aerated, and it is not feasible to get much of the organic matter oxidized by atmospheric oxygen, because it is in the molecular state. It is necessary to oxidize that organic matter either through the use of what in earlier days we used to call atomic oxygen, or else to do it with the aid of bacteria.

Q. Then is it a correct statement that the benefit of the introduction of air into the sewage, into the intercepter, will arise from the fact that it will restore the dissolved oxygen in the sewage?

A. It will restore and also will maintain; it will prevent the absence or lack of oxygen in the sewage from occurring.

Q. Is this proposal purely theoretical and a laboratory proposal, or is it a recent device of yours, or has it been put into actual operation?

A. It has not been put in actual operation as a direct working program. I have had a good deal of experience in applying air
1236 in the activated sludge process which is regarded extremely free of the odor complication; but if your question is directed to whether or not it is a recent line of sewage treatment occurring to me, it is not. It is set forth in my book which was published in 1912, and it was also recommended by me for consideration in the event of an outfall sewer being taken to an outlet island opposite Coney Island. That is, I recommended that as a part of my report in 1914 to the Metropolitan Sewerage Commission.

Q. Has it been applied in aqueduct work?

A. The correction of the limitation of oxygen, either the absence of oxygen or the very low oxygen content found in water supplies, has been corrected in that way. It is one of the principal characteristics as the ordinary visitor goes to the Catskill aqueduct works. There are very extensive works for the aeration and oxidation of the water leaving the Catskills just below the Ashokan reservoir. There is another aeration fountain of large proportions below the aqueduct of the Kensico reservoir. I have also been advising very recently the installation of aerating facilities for the City of Philadelphia for the water supply taken from the Schuylkill River, which at times gets down to 6 per cent oxygen content. Likewise, aerating
1237 arrangements at Chester, Pennsylvania, where the water supply is taken from the Delaware River within a dozen miles of the discharge sewage of the City of Philadelphia.

Q. What is the purpose of the aeration process so far as its effect on sewage is concerned?

A. It is to keep the bacterial decomposition on an aerobic basis and to prevent the putrefactive changes which lead to the offensive odors.

Q. Is it a proposal for continuous use?

A. No, I proposed it, having had in mind that it would not be used

unless there was occasion or need for it; and in no event do I assume that it will be necessary during the next few decades to use it in anything other than very warm weather.

Q. You are now having in mind what particular works?

A. I mean works for the aeration of the sewage flowing in the Passaic Valley trunk sewer.

Q. In your testimony in June last you suggested as an additional arrangement, the flushing of the contributing sewers and of the intercepter. Prof. Landreth in his testimony, given in answer to this, appearing at page 1039 of the transcript, criticises this proposal. In fact, I refer now to the bottom of page 1038 and running

1238 into page 1039:

"His next plan, the sexenth, is to overcome the stranding of solids in the tributary sewers having flat grades, by using what he calls a flushing gate."

As a matter of fact, Mr. Fuller, do you know about the grades of the Passaic Valley sewer?

A. The Passaic Valley trunk sewer has unusually good velocities, and progressively becoming higher as one moved from the upper end toward the pumping station.

Q. I continue the reading of Prof. Landreth's testimony:

"I have already referred to that in my characterization of one of his other methods, namely, he puts an obstacle temporarily in the sewer at a manhole, a gate, which dams up the flow of sewage, so that it does not go past the manhole, but in turn accumulates by backing up into the sewers, and when a sufficient amount of sewage has been accumulated, he opens the gate and lets it flush down.

"I have already spoken of that, and the effect of such an arrangement, that whatever effect it has, is one of improvement below the point of damming, but it creates another one equally great and usually greater on the portion of the sewer covered by the dam. In other words, he throws down more solids than he is able to move out by the same method. He must, therefore, carry his remedy successively upstream, manhole by manhole, and overcome the harmful effects which he has produced by the sedimentation in each case. That method has been repeatedly tried by sewer superintendents, and occasionally by engineers, who were not experienced in sewer behavior. I have seen it tried in at least a dozen places. It never has been employed more than two or three times in any one place. It is always abandoned as a hopeless and ineffective and expensive way of doing work which involves continual remedies. You are driving your disease from one point to another, and you must keep following it up with the same remedies."

Is that true, Mr. Fuller?

1239 A. It is not true.

Q. In what respects is it not true?

A. It is not true with regard to the use of these flushing arrangements in sizable works in practice in this country and in Europe,

and it is not a complete statement of what takes place with these flushing arrangements, in that the Professor apparently leaves out of view a controlling factor, and that is the question of whether or not with these flushing arrangements there is developed a scouring velocity sufficient to move these solids out. That is the very keynote of success.

Now, if for 23 hours during the 24, you have low velocities and stranding of solids, and if for some interval during the remaining hour of the 24 you scour out those solids, you accomplish the results which I had in mind in giving my testimony in June. It is the failure to recognize that scouring velocities can and should be secured to bring about this elimination of stranded solids.

Q. Have you had any personal experience with this method of cleansing sewers?

A. Yes. It is a thing that we use regularly in the work that comes to my office. In fact, a good deal of my work on sewerage
1240 systems is limited to communities with very flat grades. That is, the private offices no longer get sewerage work in communities where there are substantial grades, under all ordinary circumstances. So, for instance, at Huntington, Long Island, there was a system of sewers designed and built under my supervision, and we used a flushing gate there regularly. It makes a difference between a gravity system and a pumping station, with all of its attending expense for motive power and attendants.

There are some three plants in Florida where I have done the same thing.

My principal experience with flat grade sewers is New Orleans, where I was a member of the Board of Engineers for some nine years, dealing with the drainage, sewerage and water supply of that community. So in that city, where their principal hill is only 27 inches high, it is necessary to go absolutely to the question of minimum grades, and these devices, and others, too, are used to eliminate the stranding of solids and the putrefaction in the warm climate.

It is a fact that in Europe where their dry weather flow is smaller, compared with what it is in this country, the cleaning of sewers to check stranding of solids is done as a regular thing. In fact, I believe you could find twenty-five years ago practically no
1241 city where it wasn't used as a regular thing; and this question of flush gates is one of the principal expedients resorted to, to bring that about. I consider it is one of the great shortcomings of the American sewerage practice, that they have not come up to the level of successful operation that is characteristic of European sewerage engineers.

Q. In these plants to which you have specifically referred—Huntington and three in Florida, including Orlando and Daytona——

A. Yes.

Q. —and New Orleans——

A. Yes.

Q. —have they been employed more than two or three times?

A. Oh yes, they have been used regularly for years.

Q. And have they been abandoned as hopeless and ineffective and an expensive way of doing the work which involved expense for motive power and attendants?

A. No.

Q. Do you know whether or not this plan of sewer cleansing has been approved of by standard textbooks on sewerage?

A. Yes, I looked through a dozen or more textbooks, and it is set forth as one of the arrangements highly favored as a successful working arrangement.

Q. Do you know whether Rudolph Hering has employed
1242 this method in his works?

A. Yes, it is one of the principal things that he found through his European investigation in 1881 and 1882, when he was sent abroad for a year or two by our National Board of Health of the United States. It is set forth in his report, and when he returned to his former position as assistant city engineer of Philadelphia, he wrote strongly in favor of the adoption at Philadelphia of these flushing arrangements for the elimination of stranded solids, with their putrefying complications in the Philadelphia sewers.

Q. Do you know whether or not the engineers recommending this method can properly be characterized as inexperienced in sewer observation?

A. I think it is the other way around; they are experienced, unusually experienced.

Q. Is this a new method suggested by you at this time, or have you had some knowledge of it heretofore?

A. I have had intimate knowledge of it for fifteen years or more. It is set forth in my book published in 1912, in favorable terms, and with the view stated that it should receive more careful consideration in this country than it has been the custom hitherto.

Q. There has been some development of this plan at Plainfield, has there not?

1243 A. We had quite a little experience with the old city plant at Plainfield where we had screens—a hand-cleaned screen—and those were operated by an attendant at night. We found that we could practically dam up the flow of sewage by the uncleaned screen. We found that the deposits of sewage solids for quite a number of hundred feet in the outfall sewer above the screens caused no trouble, because of the fact that when the screen was cleaned, or the sewage diverted to a second screen which was clean, we got a velocity of 28 inches per second, that would actually flush out these stranded solids. I had in mind that experience when I spoke earlier in my answer to a recent question, that the critical controlling feature is whether you get the scouring velocities, and not whether you get depositing velocities for quite an interval. The thing that you must get is the scouring velocity.

Q. Now, Mr. Fuller, another suggestion made by you in your testimony in June related to varying the pumping rate. At page 1032 of the transcript, containing the testimony of Prof. Landreth, and also at page 1174, appear some comments and criticisms of this plan by Prof. Landreth. Have you read that testimony?

A. Yes, sir.

Q. What reply have you to make to it?

1244 A. Well, the varying of the pumping rate bears on several different elements; one of those is the lowering of the rate at times when the velocity of flow of water in the bay is relatively low,—shortly before and shortly after the turn of the tide; the other feature related to the matter of being able to store up sewage in order to make a variation in the rate of pumping; that is, if the pumps were operated at a slow rate, in order to lessen the volume of sewage to be diluted by the bay water when traveling at lower velocity, there must, of course, then be a building up of the volume of sewage, either in the trunk sewer or in the sedimentation basins, that would then be, in a measure, detention basins.

As I understand Prof. Landreth's criticism, he was speaking about the disadvantages of storing the sewage in the trunk sewer, on account of the depositing of solids.

My reply to that is, that if there is an increase, as there must be, above the average rate of pumping, so that you get a scouring velocity, then it makes no difference whether you deposit them for a limited period or not.

I want to say in that connection that there should be no difficulty with the depositing of solids in the Passaic Valley trunk

1245 sewer. Its slope is such at the lower end, that under all ordinary circumstances the velocity of flow would be far above the 2½ feet per second necessary to move ordinary sewage solids.

In regard to the dilution out in the bay at a time when the velocity is relatively low for the moving bay water, I suggested that as a helpful factor in times of unusual summer conditions—perhaps not being a factor, however, for a good many years in the future. The Professor criticised that suggestion of mine on the basis, as I recall, of not being able to locate when these low velocities would occur in the bay water.

Q. Let me interrupt you and read from page 1176 of the transcript, containing Prof. Landreth's testimony on cross-examination, the seventh line from the bottom:

"That is an indication there that you will get better results. He means to imply that will better conditions; and I repeat what I said before, that I think his means of accomplishing the better results by varying the discharge through the nozzles to correspond with the discharge of tide past the nozzles, that that is impracticable, and that he can not time the one to fit the other."

Is that the part of his testimony that you are now referring to?

A. Yes. I was about to proceed to say that it would be necessary, or course, to develop practical working knowledge as to what the regimen is of the moving currents of bay water at the dis-

1246 persion area. That is a terminal house or structure within twelve or fifteen hundred feet from the outlet end of this set of dispersion nozzles. I have assumed, of course, that there would

be stationed there an observer during the earlier months and years of operation. There would be recording devices, tide gages, tide level recording devices. It would be perfectly feasible, also, to install a current meter to note when the currents at a considerable depth above the nozzles would be below the average and what its relationship would be to the tides at Governors Island, or whatever the tidal almanac and charts would give reference most conveniently. It would also be convenient, to develop by actual experience what the time interval would be as to change in pumping at Newark Bay pumping station and the corresponding hours of the effect of that change out at the dispersion area. I assume there would be telephonic means of communication between this observation structure near Robbins Reef Light and the office of the man in charge of the Newark Bay Pumping station.

If the Professor's thought were directed to what he or I or anyone else might develop, with knowledge that is now available, I can see what would prompt him to take the attitude that he did. My thought that I am now setting forth is that it is perfectly feasible to
1247 develop a regimen of procedure, state that in practical terms, and put into intercommunication the observer at the outlet end and the operator of the pumps. It is a thoroughly workable proposition.

I want to go back and say one or two words on two other matters. If the pumps, as I have already explained, were operated at a slow rate, it would make some deposits above the pumping station. It is perfectly feasible to move those out at times when pumps are working above average capacity. My point is, the pumps must operate at a velocity sufficient to create a scouring velocity. With that done, you are all right.

The other point I believe I have scarcely mentioned is, that Prof. Landreth speaks very disparagingly of detention basins. I presume that he means by that, basins in which sewage stored in some measure during intervals when the rate of pumping is lessened. It is not necessary to use these present sedimentation basins in that connection other than in a perfectly normal way. Their flow line is some 20 or 30 feet above low water and it is perfectly feasible to draw off a portion of that upper content of the liquid, if that should prove necessary or desirable. I have in mind that that would be done in con-
1248 nection, of course, with varying levels of the sewage flow in the trunk sewer.

In the statement of Prof. Landreth, I think he states that the detention basins have practically gone out of vogue.

Q. I read in that connection from the bottom of page 1034 of the transcript:

"It differs with the wind, and numerous things; so that it would be impossible for him to time his pumping to conform to the periods of low tidal discharge over the nozzles. If he were to accomplish that, even if he were able to make such a schedule, it would convert his sedimentation basins and the trunk sewer tunnel into what has been tried in the past and abandoned almost everywhere; namely, into

partial tidal-detention basins—basins intended to store up sewage until the tide was favorable to take it out, and then let it go."

Is that the statement that you referred to?

A. Yes. Those detention basins have a very helpful use. It is true that in some instances they have been of a size and of such an operating arrangement—at such an operative arrangement that some difficulty as to odors has been produced, but it is perfectly feasible to eliminate all that. I have used detention basins and am using them now. In fact, within the last two or three weeks, I have received bids for tidal detention basins at Stamford, Connecticut. I recommended one at Stratford, Connecticut, that is now being built by another engineer. We have one at Huntington, Long Island. I recommended one at Hampton, Virginia. They are used very
1249 frequently around the seaside resorts in England to discharge the sewage flow on the outgoings tide. They have a distinctive helpful use under some circumstances, and within the range of my practice and observation, they are not going out of vogue. I might mention in that connection that the storage of sewage is something that is not extraordinarily unusual. I know the city of Wildwood, New Jersey, allows the sewage to build up in its entire sewerage system and limits its pumping to a few hours during the day. The reason why I use detention basins at these points is in a considerable measure due to the fact that we cannot get a gravity flow of sewage for some of these sewer systems, except at a lower level of tide water than occurs at high tide, and then we store up the sewage at high tide and release it on the out-going tide, when the tidal water is at a lower level.

Q. Now, directing attention to the testimony of Professor Landreth, cross-examination appearing at page 1174 of the transcript, referring to the variation of the pumping rates, middle of the page, the question was asked: "What are the objectionable consequences that you anticipate?" and he answered:

"That the variation of the rate of pumping will produce
1250 a variation in the flow, not only from the detention basins, but also in the trunk sewer tunnel above the pumping station. Thus, if the pumping is reduced to one-half its velocity, or is stopped altogether, the discharge and flow in the velocity through the detention basin will be reduced in velocity correspondingly; and in a similar manner, if the pumping is reduced to one-half, or is stopped, the flow in the tunnel will be diminished, and as the flow in the tunnel is diminished, the deposition of solids in the tunnel will increase, and sedimentation will take place in the tunnel."

Will that be the result, in your opinion?

A. It will not be so, if he means by "tunnel" the outlet tunnel out into New York Bay. I will speak of it in the sense of his having possibly referred to the tunnel both above and below the pumping station. Above the pumping station, that would be corrected, as I have already carefully explained, by the creation, with the resumption of pumping, of a velocity which would create a scour. I have also stated that the slope above the pumping station is such

that there would be an unusually high velocity normally; there would be no difficulty above the pumping station. Below the pumping station, that tunnel going under Newark Bay and on out to the dispersion area in New York Bay near Robbins Reef Light, that sewage would, of course, if it had suspended matters in it, respond to the same conditions as to the high velocities and elimination of solids as I have discussed. But as a matter of fact, the velocity wouldn't be at any time lessened, to anything like as low as would be the case in the sedimentation basins; therefore,
1251 there would be substantially no deposits to occur, because the sewage had already been freed of those matters which are removed by sedimentation.

I am speaking now having in mind that a velocity of half an inch per second or much less than that through the basins is very small as compared with a velocity of a foot or foot and a half per second, that is, 12 to 18 inches, through the tunnel leading out into New York Bay.

Q. Directing your attention to your testimony in June last, as to the introduction of chemical precipitation into the system of the Passaic Valley sewage works, at page 1035 of the transcript of the testimony, Professor Landreth's direct examination contains the following statement:

"Mr. Fuller proposed that also as an emergency measure, and not as a regular measure. The removal of suspended solids by chemical precipitation is a well-known and established method. It is perhaps the oldest method of intelligent scientific sewage disposal, certainly in the earlier plants, and at one prominent plant at least operated on the chemical disposal system, but that is operated with carefully planned sedimentation basins, basins into which the sewage may pass, and means for mixing the sewage with the chemicals before they are allowed to settle. Mr. Fuller does not propose anything of that sort here. He proposes to introduce them just at the point where the sewage enters the basins."

What have you to say as to that criticism, Mr. Fuller?

A. I assume that that criticism is directed primarily to the fact that I propose chemical treatment only on those occasions where there is real need for it. It is a fact that I propose it for
1252 emergency use and not for regular use. He also speaks about there being no arrangement for applying the chemicals, in the sense that there are no plans, perhaps, produced to show how and where it would be installed. In regard to this arrangement, it is perfectly feasible to carry that out whenever occasion requires. It is a fact, however, that I do not offer it as a suggestion for continuous use. I offer it as a means of bettering the quality of effluent sent into the Bay, if and when in after years the need for it should arise. I am speaking and having in mind as to what has happened in Providence, Rhode Island, now, where they used this chemical precipitation method in earlier years and have eliminated the application of chemicals in a very large measure. That is set out in reports and is described at length in re-

gard to the London experiences, which I have looked into personally.

In regard to the functioning of this chemical precipitation process, it is perfectly feasible to apply chemicals in an amount sufficient to bring about a massing together of these tiny particles, which have been spoken of here as colloids. They are so fine that they will not respond to the law of subsidence in plain sedimentation basins. In order to make this process effective, it is necessary to add chemicals—sulphate of iron or sulphate of alumina,
1253 so that there will be formed the sticky gelatinous hydrate, either of iron or alumina, whichever is used. If an amount of chemicals is added sufficient to bring about an area or volume of this sticky substance, so that the tiny particles can be attached to it, you can bring about clarification, and you can do it in basins of this size; that is, with a detention period of one or two hours.

In regard to the speed of reaction, it is perfectly feasible to apply the chemicals either at the inlet to the basin, or it is entirely feasible to get arrangements for applying the dry chemicals to the flowing sewage in the trunk sewer at some point above the pumping station.

The application of chemicals with arrangement for handling them in the dry form as compared with putting them in solution, has been a development of the last few years. At Washington, for instance, with their water supply, where they have a very turbid clay bearing water, during the last ten years or so, they applied this kind of chemicals at intervals, amounting to perhaps 30 to 60 days in a year; that is to say, they put them in when there is need of putting them in, and do not otherwise apply them; and they also apply them to a manhole into the aqueduct leading from Great Falls to Dalecarlia reservoir; also on the Catskill
1254 Aqueduct, with the water coming from the Catskill Mountains. I have been connected with an arrangement recently, whereby chemicals would be added if they ever had a very heavy rain, in the Catskill Mountains, particularly when the frost is coming out of the ground. That plant has been built for more than two years—I think more than three years. It is at Pleasantville, New York; it has never been used in regular operation. It allows the chemicals to be discharged at a manhole on the aqueduct. It will be used just as I propose to use it here on the Passaic Valley project when and as required. If it is never required, it will never be used.

Q. You referred to some reports of the operation of this particular device and process in London. Have you that report?

A. Yes.

Q. What is its date and title?

A. I have a copy of a paper entitled "The Main Drainage System of London. By George William Humphreys," who is the chief engineer of the London County Council, which controls this and various other utility works, and it was a paper presented in February, 1917, before The Institution of Civil Engineers. These

are the advance printed sheets, proof of that document, of
1255 which the original appears in the 1917 proceedings of that institution. The paper sums up the views as I have discussed them and seen the situation in 1912, when I last visited them; sums them up and agrees with what I understand to be the conditions, and what I understand to be set forth in the official reports of the Engineering Department of the London County Council.

Q. Will you read it?

A. It is two pages or so. I am reading at page 40, the sub-heading "Disposal of Effluent."

"At the time the Royal Commission was appointed in 1882, and until the precipitation-works were in operation 9 years later, the condition of the lower reaches was stated to be unsatisfactory. The evidence brought before the Commission, however, tended to show, and experience has demonstrated, that it was the solid matter in suspension which caused a nuisance, the mud-banks, which are inevitable in a river like the Thames, and the foreshores, being coated with sewage solids subject to rapid putrefaction in hot weather. It is to be noted, however, that the complaints were limited to the state of the river for a length of roughly 7 miles up- and down-stream from the outfalls. No evidence was produced of any considerable pollution higher up.

The effect of the elimination of the greater part of the suspended solids at the outfall and their conveyance to sea as sludge was immediate. Since this operation has been effected, the change in the condition of the foreshores and the river has been remarkable, and no complaints have been received as to the condition of either. For some years observations have been taken of the condition of the river near the outfalls, and latterly these observations have been extended to the tidal limit at Teddington and into the estuary at large. It is hoped that the data so obtained may furnish material on which an opinion can be founded as to the amount of effluent that can eventually be assimilated by the river without any serious annoyance.

The volume of effluent now discharged amounts to about 280
1256 million gallons per day, an increase of 80 million gallons over 20 years ago. Compared with the past, it is composed in part of rainfall that formerly was discharged into the river by means of the old main sewers in the metropolis itself. The volume of the tidal flow past the outfalls varies between 15,000 million gallons on a spring tide, and 13,000 million gallons on a neap tide. It is considered that the amount of dissolved oxygen in the water is the best measure of the condition of the river as regards its liability to cause a nuisance. The test for dissolved oxygen absorbed in 5 days, as recommended by the recent Royal Commission, is stated not to have yet been found altogether applicable to the conditions found in tidal waters. Generally speaking, although other factors play their part, it can be said that the amount of dissolved oxygen in the river, at and above the outfalls, depends upon the quantity of upland water coming down the river. In periods of flood, when upwards of 2,000 million gallons per day are flowing over Teddington weir, the per-

centage of maximum aeration of the river at low water at Barking (which gives an indication of the condition of the river above that point) is between 40 and 80 per cent. On the other hand, in times of drought, with possibly less than 400 million gallons per day coming down, the aeration may be less than 5 per cent of the maximum possible. Generally it may be said that the aeration of the water, with an average quantity of upland water flowing at Teddington, decreases from full aeration at the tidal limit (Teddington) to about 20 per cent of maximum aeration at the outfalls (30 miles distant), and generally increases again below the outfalls, approximately full aeration again being reached about 23 miles still lower down in the neighborhood of the Chapman light at Southend. The large seasonal variation in the proportion of oxygen dissolved in the water, which in the winter and spring months reaches a high percentage for long periods when even the 5 days' absorption test yields results even superior to those recommended by the Royal Commission as applicable to a non-tidal river, had drawn attention to the possibility of sedimentation being adequately attained during these periods without the use of the lime and iron precipitants. For 3 or 4 years the experiment has been tried, for some months at a time, of omitting the use of chemicals at one or both outfalls, at the same time carefully testing the condition of the river-water with the result that it has been recognized that their disuse during a considerable part of the year is warranted. For the remainder of the time, as their
1257 presence undoubtedly tends to improve conditions when a large demand is made upon the purifying capabilities of the river, their use is both advisable and desirable.

As to the degree of aeration that a large tidal river like the Thames should possess, there may be differences of opinion. A theoretically pure Thames is impossible of attainment, and the question resolves itself into one of degree and of what is reasonably necessary for the well-being of the community. At present the results justify a continuance of existing methods, and it is felt that they will be adequate for some years to come. The Main Drainage Committee of the London County Council, however, in view of possible requirements, advised the purchase of large tracts of land in the neighborhood of the two outfalls, and about 750 acres have accordingly been acquired by the Council. This has the effect of isolating the outfall works, and at the same time the land is available if it should be decided later to adopt biological treatment by tried bacterial processes or by any other method that future developments may suggest. The volume of effluent to be dealt with is, however, of such dimensions that the entire conversion of the above-mentioned land into, for example, a filtering area is probably an undertaking that could never be advocated, if indeed it ever became necessary to treat further the whole of the effluent. The treatment of a percentage only, to be increased within limits as necessity might arise, would furnish one method of dealing with future requirements; but if through extension of drainage-area a very much larger quantity of effluent is to be disposed of in the future, the conveyance of the whole or a large percentage of it to a more open point of discharge will, in the Author's opinion, become

a practical question. The relatively small costs of conveyance sludge to sea from the London outfalls, coupled with the facility with which this is done, are such that, whatever further treatment may become necessary, this operation is bound to be continued, unless some method, hitherto impracticable, of rendering the sludge a marketable commodity comes to the fore. Experience has shown that no prejudicial results accompany its emission at the discharging grounds. Its elimination has been productive of such good results that expenditures upon an increase in the accommodation for precipitation and further facilities for its separation will be justified in the future.

Dr. O'Sullivan: I would like to ask one question. I didn't
1258 object to your reading that into the record. I would like to know what your object is in reading that into the record.

Witness: To show the elimination of chemical precipitation as a continuous twelve-months-in-the-year performance at London. That is what a more careful study showed to be a reasonable procedure, and with a plant—the largest in the world of that kind, and starting with this program in 1911, twenty years after the plant went in service, they studied it from 1911 for three or four years or more, and find it is feasible to omit the chemical precipitation for a substantial portion of the time. That is, I am bringing that to the front, to indicate that the intermittent use of chemicals for the Passaic Valley project is a reasonable one, to apply them when and if necessary, and not to apply them when it is not necessary. And this is supporting precedent to which I, with my knowledge of London conditions, attached a good deal of importance.

Dr. O'Sullivan: And have they eliminated the chemical treatment of sewage for the purposes of increasing precipitations? They have eliminated the chemical treatment permanently, have they not?

1259 Witness: No, I don't understand so, for all time; I think during the summer months, during warm weather, they do put in the chemicals. I think at Providence it is true that they have eliminated the use of chemicals as a precipitant for some years, twelve months in the year.

Q. Mr. Fuller, I read against on page 1035 of Professor Landreth's testimony: "Mr. Fuller proposed that also as an emergency measure, and not as a regular measure." I understand that you read this extract, to show that it conforms to practice in London?

A. Yes, sir; and I will add that it conforms with practice at Providence, Rhode Island, too.

Q. I read at the top of page 1036 of the transcript of Professor Landreth's testimony, on direct examination:

"There is one other point which should have attention, and that is the nature of the sewage itself. Frequently its chemical nature is an important factor in the efficacy of chemical treatment of the sewage. If the sewage itself is already treated in chemicals, that treatment may aid or impair the effect of the artificially-added chemicals to use for precipitants. It may also lead to a production of artificial odors, which would not be produced under normal conditions.

Now, in this present case, Mr. Fuller states that one-tenth of the whole volume of sewage entering this trunk sewer, is to consist of trade wastes from the industries on the Passaic River. We do not know what those trade wastes contain, but undoubtedly they contain more or less chemical materials; and before such a plan as this is embarked on, a careful, chemical investigation of the sewage itself, particularly its chemical nature, should be made before a chemical precipitation solution is offered as remedy for existing evils." What knowledge have you of the effect of chemicals contained in
1260 the sewage body and their treatment by chemical precipitation?

A. I have had quite a little to do with the study of industrial wastes in this district, and particularly the textile industry in Paterson. I have had occasion to study the wastes from the Weidmann Silk Dyeing establishment in Paterson, and also advised the installation of a chemical precipitation plant for the United Piece Dye Works at Lodi, New Jersey, on the Saddle River. I know that these wastes do vary in composition at frequent intervals. There are times when the wastes will precipitate—re-act upon each other and bring about adequate precipitation. There are other times when it is necessary to add a good deal of either iron or sulphate of alumina to remove all of the polluting substances; or with 90 per cent sewage flow and 10 per cent industrial wastes, I consider that it is perfectly feasible to keep that well under control; and I am aware that it would be necessary, however, in applying chemicals above the Newark Bay pumping station or at the inlet to the basin, to know what chemicals are being discharged into the sewage at that time, so far as their re-action is concerned in connection with the precipitants in use. Those are all controllable matters. The industrial wastes at Worcester, with their pickling liquors, are a much more disturbing element than would be the textile
1260a wastes in the Passaic Valley trunk sewer. They can be handled by good management, though. I have seen this precipitation process used in a good many places in England. It is a thoroughly workable process for an industrial valley.

There is one point in regard to the speed of reaction that, perhaps, I should mention; that is, that the various fine particles are massed together into flocks of a size, where the flocks of a size will subside, depending upon the amount of chemicals added. I have had a good deal of experience with the clay-bearing waters in the southern states, and know that it is feasible to bring about coagulation and sedimentation in basins as small or smaller than those adjacent to the Newark Bay pumping station. I speak of their size relatively, of course, in connection with the flow to pass through it.

Q. The criticism in regard to the emergency use of these chemicals, Mr. Fuller, is that justified by experience in the use of them?

A. No, it is a criticism that would apply with equal force to the managers and operators of the water supply of the City of Washington, or the Catskill supply, supplying the City of New York. It is perfectly rational to use a purifying arrangement when and
1260b if necessary. If it is not necessary, there is no need of using it. That is a thing that I have seen time and time

again, with water purification arrangement; with some limited measure, also with sewage disposal; but it is feasible, as set forth in the report of the Chief Engineer of the works at London.

Recess.

1261 GEORGE W. FULLER, recalled for further

Direct examination.

By Mr. Riker:

Q. There was an objection made to the marking of Defendants' Exhibit No. 12, on the ground that the exhibit did not embody the preliminary correspondence, and particularly did not contain or involve the letters referred to in it. Now, Mr. Fuller, during recess have you done anything to supply the papers that were referred to and laid the ground of the objection to the offer of that exhibit, and if so, what?

A. Yes, I went to the office of the Passaic Valley Sewerage Commissioners and compared a copy as furnished to me of the letters referred to in Exhibit No. 12, those being letters addressed to the District Engineer by the Passaic Valley Sewerage Commissioners under date of April 8 and May 6, 1913. I saw the carbon copies on the files of the Passaic Valley Sewerage Commissioners and found that the copies which I have here are correct transcripts of the official file copies, that is, carbon copies on file in the records of the Commission. I found also an intermediate letter not spoken of in this Defendants' Exhibit No. 12, but it is a part of this correspondence.

Q. Who did you say furnished you with these papers and letters which you have?

1262 A. I was furnished these documents by Messrs. Brown and Taylor—they were each present—during the last half hour.

Q. Mr. Brown, the chief engineer of the Passaic Valley Sewerage Commissioners?

A. Yes.

Q. And Mr. Taylor is who?

A. He is the deputy chief engineer in charge of designs.

Q. And did you make a comparison of those papers with the papers on file in the office of the Commissioners?

A. I did.

Q. And are they correct copies?

A. They are correct copies.

Mr. Riker: I offer these as one exhibit and suggest that they might be marked Defendants' Exhibit No. 12A.

Commissioner Maher: The exhibit will be received and marked Defendants' Exhibit No. 12A, subject to objection of counsel for complainant.

"Copy.

File 100, Administration.

U. S. War Department. April 8, 1913.

Col. William T. Rossell,
Corps of Engineers, United States Army,
Army Building, Whitehall Street,
New York City.

DEAR SIR:

By permit issued by the Secretary of War under date of
1263 May 11, 1910, the Passaic Valley Sewage Commissioners are authorized to locate a sewer outlet and shaft house in the vicinity of Robbins Reef in the Bay of New York, and to construct certain appurtenant works in accordance with stipulated conditions and a set of plans bearing file number of the Office of Chief Engineer, United States Army, '20,103, 111-170.'

On the drawing referred to (see sheets Acc. Nos. B1043-B1045 inclusive) there are indicated four sets of moving screens to the continuous link-belt type, these screens having a stipulated clear space between the bars not to exceed 0.4 of an inch.

The Passaic Valley Sewerage Commissioners are advised by their engineer that in his opinion it is advisable to substitute in the place of the continuous link-belt type of moving sewage screens, a gang of three sets of semi-fixed cage screens with two screens in each set making a total of six individual screens. Each screen is to be twelve feet in width with approximate clear openings between the screen bars in the proposed screen cage to be as indicated on the sketch hereto attached (Acc. No. L1507).

The engineer is of opinion that the semi-fixed cage screens recommended by him will intercept more of the suspended matter in the sewage flow and will be more positive in action and suffer less interruption in the maintenance of the mechanism.

The Passaic Valley Sewerage Commissioners hereby respectfully request that the semi-fixed cage screens as described may be authorized, approved and permitted, and that the Commissioners may have permission to use either said semi-fixed cage screens as described or the continuous link-belt type of moving screens as required in the permit issued by the Secretary of War under date of May 11, 1910.

Very truly yours,

PASSAIC VALLEY SEWERAGE
COMMISSIONERS,

By —— ——,
Chairman."

1264 "Copy.

United States Engineer Office.

District No. 3.

Room 802, Army Building, 30 Whitehall St.

New York City, April 30, 1913.

Mr. Francis Child,
Chrm., Passaic Valley Sewerage Com'n'rs,
Newark, N. J.

SIR:

Referring to your letter of the 8th instant with accompanying blue-prints in triplicate, in which you propose to substitute in the place of a continuous link-belt type of moving sewage screens, a gang of three sets of semi-fixed cage screens with two screens in each set * * * I have to say that in making a comparison between the screens now proposed and those shown in the original drawings I am in doubt as to the exact purpose of this change, and if convenient would be pleased to have you explain this to me further in detail. Upon receipt of this information I will be ready to take action upon your proposition.

Respectfully,
(Signed) WM. T. ROSSELL,
Colonel, Corps of Engineers."

"Copy.

May 6, 1913.

Col. William T. Rossell,
Colonel, Corps of Engineers, United States Army,
Army Building, Whitehall Street,
New York City.

DEAR SIR:

In reply to your inquiry of April 30th, in relation to screens for Passaic Valley Sewerage Works, the following statement will amplify the reasons for requesting from the Federal authorities permission to substitute semi-fixed cage-screens for the continuous link belt type of moving screens incorporated in stipulation and permit.

The type of screen stipulated in the permit signed by the Secretary of War, May 10, 1910, is similar to the screens which
1265 have been constructed and operated at the sewerage works of Hamburg, Germany. The clear spacing of the screen bars and the self-cleaning features of the stipulated screens parallel the features of the Hamburg Screens.

Since the date of the permit additional data as to the effectiveness of the Hamburg screens is now available. A comparison of their

working efficiency can now be made to better advantage than was possible in 1909, when the stipulation was drafted and signed.

In a German publication entitled 'Die Kanalization der Freien und Hansestadt Hamburg' by Baurat Curt Merckel, published 1910, there is a detailed description of the construction and operation of the Hamburg sewerage works.

On page 212 it is stated that 6,000 cubic meters of material is removed per annum from the screens. The population tributary to the works at the date of the publication is about 1,000,000. It then appears that the material removed from the screens is equivalent to 7.85 cubic yards per 1,000 tributary population per annum.

Records of the amount of material removed from the semi-fixed cage-screens of the type suggested for substitution are given in the annual reports of the Metropolitan Water & Sewerage Commissioners (Boston) and condensed in a publication entitled 'Sewage Sludge' by Kenneth Allen, page 205.

This record indicates that the semi-fixed screens on the Boston Metropolitan District removed, during the six years 1905 to 1910 inclusive, an average of 12.64 cubic yards, of material per 1,000 tributary population.

The costs of semi-fixed cage-screens for the Passaic Valley Sewerage work would not exceed $30,000.00. The estimated costs of screens of the continuous link-belt type is $60,000.00.

Operating the maintenance charges and depreciation will unquestionably be much greater for the continuous link-belt self-cleansing screen than in the semi-fixed cage-screens. The self-cleansing screens are the more complex and include many links and joints which of necessity operate in and out of the sewage.

The substitution of the semi-fixed cage-screens is desired for the following reasons:

1. They remove a large percentage of the suspended matter in the sewage.

1266 2. They are lower in first costs of installation.

3. They cost less to operate and maintain.

4. There is less danger of interruption from mechanical difficulties.

Yours respectfully,

PASSAIC VALLEY SEWERAGE COMMISSIONERS.

——— ———,

Chairman."

Cross-examination.

By Dr. O'Sullivan:

Q. Where did you see and from whom did you get these copies of the letters that passed between the District Engineer of the United

States Army in New York City and the Passaic Valley Sewerage Commissioners?

Witness: You mean the copies you hold in your hand?

Dr. O'Sullivan: Yes.

A. I got them when I left the room this morning—I don't know whether it was Mr. McCarter or Mr. Riker. I went with that copy to the Passaic Valley Sewerage Commission and compared them with the copies which Mr. Brown and Mr. Taylor showed to me.

Q. Did you compare them yourself?

A. Yes, sir, I did.

Q. What is meant by the "Hambury screens"?

A. The Hamburg screens.

Q. That is a mistake?

A. A typographical error.

Q. Did you notice that when you made the comparison?

1267 A. No, I really did not.

Q. The substituted screens that you have approved of and that request has been made on the War Department not to object to, would cost approximately one-half what the stipulated screen would cost, is that correct?

A. I think it is so stated there. I am of that opinion, yes, from memory.

Q. What is your knowledge on the subject?

A. I haven't looked into the matter; I don't know.

Q. Why should the stipulated screens cost twice as much as the substituted screens?

A. It is more complicated operating mechanism, I should think, for one element; and another element is, that the material is probably different.

Q. The sewage?

A. The material of which the screen is made.

Q. Do you understand upon what grounds application was made for the substitution, Mr. Fuller?

A. I read what is set out there in Exhibit No. 12A as to reasons which involve the greater efficiency of the substituted semi-fixed cage screens than would be obtained with the so-called Hamburg type, being self-cleansing revolving link-belt type.

Q. And that claim was based upon experience in Boston as against experience with the screens in Hamburg?

1268 A. That is set out there in that exhibit.

Q. And you so understand it?

A. Yes.

Q. Do you also understand that the sewage of the Metropolitan District of Boston in any way resembles the trade wastes and sewage that is being treated in Hamburg?

A. Well, I should say that they were not exactly identical; neither, on the other hand, would I put them in a different class. That entire community or center of population is what you call an industrial district. They are each residential and commercial. I don't want to say but what there is some manufacturing in each in-

(4 D 12 A)

COPY.

File No. ----
Stamp → Administration

U.S. War Department
New York } No. 3 Original
New Jersey }
Defendants Exhibit No. 12 a James D. Maher
Commissioner

April 8, 1913.

(at p 1268)

Col. William T. Rossell,
Corps of Engineers, United States Army,
Army Building, Whitehall Street,
New York City.

Dear Sir:-

By permit issued by the Secretary of War under date of May 11, 1910, the Passaic Valley Sewerage Commissioners are authorized to locate a sewer outlet and shaft house in the vicinity of Robbin's Reef in the Bay of New York, and to construct certain appurtenant works in accordance with stipulated conditions and a set of plans bearing file number of the Office of Chief Engineer, United States Army, "20103, 111 - 170".

On the drawings referred to (see sheets Acc. Nos. B1043 - B1045 inclusive) there are indicated four sets of moving screens of the continuous link-belt type, these screens having a stipulated clear space between the bars not to exceed 0.4 of an inch.

The Passaic Valley Sewerage Commissioners are advised by their engineer that in his opinion it is advisable to substitute in the place of the continuous link-belt type of moving sewage screens, a gang of three sets of semi-fixed cage screens with two screens in each set, making a total of six individual screens. Each screen is to be twelve feet in width with approximate clear openings between the screen bars in the proposed screen cage to be as indicated on the sketch hereto attached (Acc. No. L1507).

The engineer is of opinion that the semi-fixed cage screens

COPY.

recommended by him will intercept more of the suspended matter in the sewage flow and will be more positive in action and suffer less interruption in the maintenance of the mechanism.

The Passaic Valley Sewerage Commissioners hereby respectfully request that the semi-fixed cage screens as described may be authorized, approved and permitted, and that the Commissioners may have permission to use either said semi-fixed cage screens as described or the continuous link-belt type of moving screens as required in the permit issued by the Secretary of War under date of May 11, 1910.

Very truly yours,

PASSAIC VALLEY SEWERAGE COMMISSIONERS,

By

Chairman.

New York v New Jersey
Complaints Exhibit No.12-A
James D.Maher,Commissioner
Page 1268-B

(f. 1268-b)

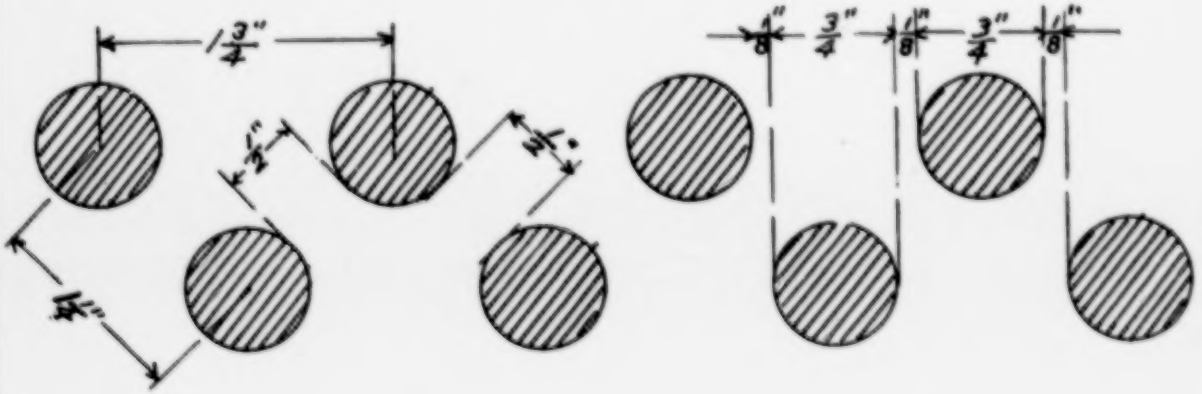
State of New Jersey

Passaic Valley Sewerage Commissioners

NEWARK BAY PUMPING STATION

SCREEN BAR SPACING IN CAGE SCREENS

MARCH 22, 1913



Direction of Sewage Flow

New York vs New Jersey
Complaiants Exhibit No.12A
James D.Maher,Commissioner
Page 1268-C

Scale:- Full size

Acc.No.L 1507

COPY.

UNITED STATES ENGINEER OFFICE,
District No. 3,
Room 802, Army Building 39 Whitehall St.,

NEW YORK CITY April 30, 1913.

Mr. Francis Child,
Chrm., Passaic Valley Sewerage Com'nrs.,
31 Clinton St.,
Newark, N.J.

Sir:

Referring to your letter of the 8th instant with accompanying blueprints in triplicate, in which you propose to subetitute in the place of a continuous link-belt type of moving sewage screens, a gang of three sets of semi-fixed cage screens with two screens in each set * * *, I have to say that in making a comparison between the screens now proposed and those shown in the original drawings I am in doubt as to the exact purpose of this change, and if convenient would be pleased to have you explain this to me further in detail. Upon receipt of this information I will be ready to take action upon your proposition.

Respectfully,

(Signed) Wm. T. Rossell,
Colonel, Corps of Engineers.

New York v New Jersey
Complaints Exhibit No.12-A
James.D.Maher,Commissioner
Page 1268-D

(1268-d.)

COPY.

New York v New Jersey
Complainte Exhibit No. 12-A
James D. Maher, Commissioner
Page 1268-E

May 6, 1913.

Col. William T. Rossell,

Colonel, Corps of Engineers, United States Army,

Army Building, Whitehall Street,

New York City.

Dear Sir:-

In reply to your inquiry of April 30th, in relation to screens for Passaic Valley Sewerage Works, the following statement will amplify the reasons for requesting from the Federal authorities permission to substitute sem-fixed cage-screens for the continuous link belt type of moving screens incorporated in stipulation and permit.

The type of screen stipulated in the permit signed by the Secretary of War, May 10, 1910, is similar to the screens which have been constructed and operated at the sewerage works of Hamburg, Germany. The clear spacing of the screen bars and the self-cleaning features of the stipulated screens parallel the features of the Hamburg Screens.

Since the date of the permit additional data as to the effectiveness of the Hambury screens is now available. A comparison of their working efficiency can now be made to better advantage than was possible in 1909, when the stipulated was drafted and signed.

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On page 212 it is stated that 6,000 cubic meters of material

(f. 1268-e)

is removed per annum from the screens. The population tributary to the works at the date of the publication is about 1,000,000. It then appears that the material removed from the screens is equivalent to 7.85 cubic yards per 1,000 tributary population per annum.

Records of the amount of material removed from the semi-fixed cage-screens of the type suggested for substitution are given in the annual reports of the Metropolitan Water & Sewerage Commissioners (Boston) and condensed in a publication entitled "Sewage Sludge" by Kenneth Allen, page 205.

This record indicates that the semi-fixed screens on the Boston Metropolitan District removed, during the six years 1905 to 1910 inclusive, an average of 12.64 cubic yards, of material per 1,000 tributary population.

The cost of semi-fixed cage-screens for the Passaic Valley Sewerage work should not exceed $30,000.00. The estimated cost of screens of the continuous link-belt type is $60,000.00.

Operating and maintenance charges and depreciation will unquestionably be much greater for the continuous link-belt self-cleansing screens than in the semi-fixed cage-screens. The self-cleansing screens are the more complex and include many links and joints which of necessity operate in and out of the sewage.

The substitution of the semi-fixed cage-screens is desired for the following reasons:

1 - They remove a large percentage of the suspended matters in the sewage.

2 - They are lower in first cost of installation.

3 - They cost less to operate and maintain.

COPY.

4 - There is less danger of interruption from mechanical difficulties.

Yours respectfully,

PASSAIC VALLEY SEWERAGE COMMISSIONERS.

Chairman.

New York v New Jersey
Complaints Exhibit No.12-A
James D. Maher, Commissioner
Page 1268-G

(p. 1268-g)

stance,—the south Metropolitan sewer in Boston and the Hamburg system, but they are not manufacturing valleys—districts.

Dr. O'Sullivan: The offer of the correspondence as an exhibit is objected to on the ground that the basis for receiving a permit or an assurance that their use would not be interfered with, by the substitution, is misleading.

Commissioner Maher: Note the objection of counsel for complainants.

(Correspondence referred to marked Defendants' Exhibit No. 12A.)

(Here follow fac-simile letters and drawing marked pages 1268*a*, 1268*b*, 1268*c* and 1268*e*.

1269 Further direct examination.

By Mr. Riker:

Q. I now read to you, Mr. Fuller, from the transcript of the testimony in this case, under the order of March 10, 1919, at page 798, the testimony of Mr. Kenneth Allen, given on direct examination:

"Q. Were you in the screen house?

A. I was, and I saw the provision for the screens, but the screens had not been installed. I was told by Mr. Taylor that they were to be of the cage type similar to those at Nut Island. Those screens are understood to be ¾-inch rods, spaced an inch and a half apart, and with two rolls staggered, so that the clear space in passing through at right angles to the side of the screen would be one-eighth of an inch; but if passing through between the bars, the space would be between ¾ of an inch and 1½ inches. I have here some figures of the amount of the screenings removed by the Nut Island screen chamber in 1918. The average removal was 5/100 of a cubic yard per million gallons; while the Hamburg screen, which is a different type, in which the bars are .6 of an inch apart, removed .34 of a cubic yard per million gallons, or seven times as much as the Nut Island."

What explanation have you for the apparent difference in efficiency of the Hamburg screen and the Nut Island screen?

A. There are two important factors to be taken into account. In the first place, the volume of screenings removed at Nut Island should be stated in connection with this fact, that of the volume of sewage going through the screens at Nut Island substantially one-half has already passed through screens; by that I mean to say, that of about sixty million gallons daily flow of sewage through the Nut
1270 Island screens, some twenty-eight or twenty-nine million gallons of sewage is screened at the Ward street pumping station; there is also some screening at a small pumping station at Quincy. That in itself, assuming that this sewage is substantially the same from all tributary sewers, would increase the figure from 5/100 to 10/100 of a cubic yard per million gallons. I have looked up the records myself for the preceding year, 1917, and find that it is 1/100ths. So that practically doubles, or a little more than doubles the fair estimate as to what screens of the type described by Mr. Allen would do with the Boston sewage, provided that the ratio of the volume of screenings to flow of sewage, took into account only the sewage which is screened for the first time.

In the second place, it is necessary to bear in mind clearly that the ratio per million gallons of sewage treated, with respect to screenings removed, is not a fair one, in the sense that the Boston sewage is diluted particularly in that south system, which has a flow of about 170 gallons per capita daily, on an average, as I recall. At Hamburg it is about four times as strong, that is, about one-fourth that volume per person.

Those two factors taken into account show that there is more sew-

age screenings removed by the cage type of screen at Boston
1271 than is the case at Hamburg, when you reference that to a thousand population tributary to the sewers.

Q. I also direct your attention to the statement by Mr. Allen in the testimony which I have already read, that the spacing of the rods at Nut Island either is, or is assumed by you to be three-fourths of an inch and one and one-half inches. If that spacing is reduced to one-half of an inch instead of three-quarters of an inch, would that affect the amount and percentage of removal?

A. Yes, I think it would appreciably. I may say there that the Hamburg screenings are supposed to be four-tenths and not six-tenths of an inch. I don't know whether that is a typographical mistake or not.

Q. And if the spacing was further reduced from one-half of an inch to four-tenths of an inch, then there would be still further removal?

A. Yes. If the Hamburg screen showed actually a spacing of six-tenths, as set out there, rather than what the records show, and what my recollection is, of four-tenths, then it would be still more favorable to the Boston screen.

Q. Have you directed your attention, Mr. Fuller, to the testimony recently taken of Prof. Phelps and the results of tests dis-
1272 solved oxygen made, or alleged to have been made in New York Bay; assuming them to be correct, what do you conclude from them?

A. I have read them, and I have noted in particular his reference to the depletion of oxygen, and the facts associated therewith. It seems to me that there are other factors besides those which he described, which should be considered most carefully in stating the reasons for the variation in oxygen content in the waters of New York Bay through a term of recent years.

Q. Assuming that these tests have been properly made and properly proved in this case, and accepting them at their face, what additional explanations or causes for the conditions disclosed by those tests occur to you beyond those stated by Prof. Phelps in his testimony?

A. There occur to me three elements to be taken into account; one of those is the variation that occurs in the dredgings of various deposits, including sewage sludge in the waters of New York Bay; secondly, there is the question of irregularities, by which I mean the inequalities with which the overlying waters are depleted of oxygen, due to the decomposition of sludge lying on the floor of the bay below.

I had in mind particularly that this is not a process that
1273 proceeds regularly with bacteria eating sewage sludge, the way a rat would eat a piece of cheese; but it is a question of the bacteria producing certain liquid ferments, known as enzymes. These substances bring about the liquefaction of sewage sludge and the release of substances which consume the oxygen in the overlying waters. These things take place irregularly. I think they should be taken into account. They should be taken into account in con-

junction also with the deposits which are removed from the New York Bay district in an irregular manner. The third point which occurs to me is based upon analyses which appear in sheet No. 3 of Professor Phelps' records of dissolved oxygen tests in July, 1919. On the twenty-second of July he took four samples of water in Newark Bay. Those are designated, as I recall, stations 17, 18 and 19; 17 is Newark Bay, opposite Centerville Light, which is, perhaps, half way between Shooters Island and the Lehigh Valley Railroad bridge, as I understand. Then he took samples opposite the Passaic Light, not far from the Newark Bay pumping station, and also at a point where the Jersey Central Railroad, Newark Branch, crosses the Passaic River, just above its junction or the entrance into Newark Bay. I was very much impressed with the fact that those four samples of water recorded on sheet 3 showed dissolved oxygen
1274 content, in two instances, opposite Centerville Light of 11 per cent of saturation, and I think the one opposite Passaic Light, 6 per cent, and the one near the Jersey Central Railroad Bridge of 5 per cent. I believe that the volume of water passing from Newark Bay with that low dissolved oxygen content is a substantial factor to be dealt with in explaining the dissolved oxygen content with its progressive depletion during the past few years. By progressive depletion, I mean a general lowering from the main water of New York Bay, and I have noted in those depletions, as noted year by year by Professor Phelps, that there are irregularities, and what he calls, I believe, fluctuations.

The point that I am speaking to is this, that as factors in explanation of those fluctuations, consideration should be given to those three elements that I have mentioned.

Q. The first element I think you mentioned was the sludge on the floor of the Bay?

A. Yes, sir.

Q. And its removal from time to time during the periods in recent years; have you made an examination as to what amount has actually been removed in the last two years as compared with prior years?

A. Yes. I sought to get that information as best I could.
1275 What I was able to secure was the record of dredging in New York Bay as those are recorded in the Annual Reports of the Chief of the Engineer Corps of the United States Army. I am speaking now of the published official documents showing the number of yards removed each year during the past fifteen years.

Q. Will you state the removals as you have ascertained them in the last five years?

A. I have a record for the last fifteen years.

Q. Fifteen years?

A. Of the volume of dredging from New York Harbor as shown, as I have already explained in the Annual Reports of Chief of Engineers of the United States Army. These figures are summarized here in thousands of cubic yards per year. I will read them for each of the years 1905 to 1918 inclusive, and I will read them in order, beginning in 1905.

Dr. O'Sullivan: Just a moment before you read those.

Cross-examination.

By Dr. O'Sullivan:

Q. Who made these summaries that you mentioned?
A. My assistant, Mr. Benjamin F. Darling.
Q. What did you do with regard to them?
A. I asked Mr. Darling to go to the office of the Army Engineers in New York and to get the official facts with respect to these
1276 dredgings. He came back and told me what he was able to get, and then I sent him back again to the Army Engineers' office and asked him to bring to me the summary of the dredgings, separated, classified and grouped as well as he could get them, and particularly to give me the total amount of dredgings for each year during the past fifteen years.
Q. You didn't see any details or data or statistics regarding these dredgings yourself at the Army Department, did you?
A. No, I did not; the records will have to speak for themselves.
Q. And all you know is that that summarized statistical matter was handed to you by your assistant?
A. Yes.

Dr. O'Sullivan: I object to its being read into the record, as purely hearsay.

Witness: Mr. Darling is here in the room now.

Commissioner Maher: Note the objection of counsel for complainant.

Mr. Riker: I will be glad to put Mr. Fuller's assistant on the stand to prove these summaries and the sources from which he obtained them, being prevented from doing that, except perhaps by consent of counsel for the complainant, under the terms of
1277 the order of March 10, 1919.

Dr. O'Sullivan: Complainants' counsel made a similar request of defendants' counsel; he was notified of the fact that the defendants' counsel could not modify an order of the Supreme Court of the United States, and the complainants bow to that interpretation of the order and the position of defendants' counsel.

Further direct examination.

By Mr. Riker:

Q. Will you read it into the record?
A. This column is headed "Thousands of cubic yards per year".

1905	2230
1906	2165
1907	1204
1908	1363
1909	800
1910	1768
1911	303
1912	1028
1913	1715
1914	1406
1915	3577
1916	3075
1917	513
1918	909

Dr. O'Sullivan: This is all in Mr. Darling's handwriting, this paper from which you read?

Witness: Yes, sir.

Q. You have stated that the examination of the oxygen determinations produced and put on the record through Professor Phelps, showed that in those determinations the oxygen content of
1278 Newark Bay was very low. Is that a correct statement?

A. That is right.

Q. What effect, if any, would the condition shown by these determinations, if made and properly proved, have upon the waters of New York Bay at Robbins Reef?

A. This low oxygen containing water of Newark Bay would certainly bring about a lowering of the oxygen content in the waters of New York Bay, due to the fact that three-fourths or more of the discharge from Newark Bay on ebb already goes northward through the Kill van Kull, rather than to the south to the Arthur Kill.

Dr. O'Sullivan: Three-fourths, you say?

Witness: Yes.

Q. 84 per cent?

A. I have been unable to put my finger on the recent figures. I have the figures in mind from 75 to 85 per cent.

Q. And the balance of the water goes through what channel, Mr. Fuller?

A. The balance goes through the Arthur Kill itself.

Q. Where does that go.

A. That goes into Lower New York Bay.

Q. And affects the flood waters, the tide waters, coming in through Lower New York Bay?

A. Yes, sir, that is bound to be something of a factor.

1279 Q. If the sewage of the Passaic Valley is put through the treatment works of the Passaic Valley Sewerage Commissioners and removed from Newark Bay, would that improve the conditions of the water at Robbins Reef in the Upper Bay?

A. Yes, it would.

Q. I think you said that you have gone over the testimony recently taken on behalf of the complainants, under the order of March 10, 1919; did you note the testimony with respect to conferences between representatives of the Passaic Valley Sewerage Commissioners and of the State of New York, with reference to co-operation of any kind?

A. Yes, I saw a reference to that subject in the testimony of Professor Landreth.

Q. Did you have any part in any such conference?

A. Yes.

Q. When was that?

A. In September, 1911; one of the days I know being September 9, 1911, it is noted in the record; that is the approximate date.

Q. Who were the parties to the conference?

A. There was Professor Landreth, beside Mr. Harrison P. Eddy and Mr. Theodore Horton, they represented the New York interests; there was also Mr. Harrison at that time I think Chief
1280 Engineer of the Passaic Valley Sewerage Commissioners, or else serving as engineer for the design of the project, and myself.

Q. Was any result obtained from those conferences?

A. No, sir.

Q. Why not?

A. Well, there are several reasons. In the first place, we found—I say "we," Mr. Harrison and myself, representing the New Jersey interests—found that there was no indication whatever of the New York representatives being disposed to consider for their own problems a standard of purification which would equal that of the Passaic Valley Commission, as they had set forth in their agreement to adhere to and adjust to. By agreement, I mean the stipulation, of course, between the United States Government and the Passaic Valley Sewerage Commissioners and the State of New Jersey. That is, it was all a question of establishing how far New Jersey would go towards purifying the sewage without any responsibility on the part of New York's representatives as to what they would do or advocate the New York interests to do. There was also an element put forth by them with respect to bringing the degree of purification of the Passaic Valley Sewage, if things would go their way of thinking, far in excess of the degree of purification thought to be necessary
1281 by the representatives of New Jersey. Those are the main elements, showing that in substance, we couldn't get together for those two principal reasons.

Q. Was there any co-operation on the part of New York suggested in those conferences?

A. Co-operation if New Jersey would do everything that they wanted to have New Jersey do, and provided that New York had nothing to do towards meeting suggestions by the representatives of New Jersey, as to meeting themselves in New York the standard of purification which they proposed for New Jersey.

Q. As a matter of fact, was there any real co-operation, either suggested or promised, by the representatives of New York?

A. There was none.

Cross-examination.

By Dr. O'Sullivan:

Q. Are you positive, Mr. Fuller, as to the membership of that conference committee?

A. I am positive as to the appearance of five men whose names I have mentioned. It is possible that there were others present.

Q. Are you quite sure that Mr. Theodore Horton was there?

A. Absolutely.

1282 Q. Are you equally sure that Mr. Kuichling was not there instead of Mr. Horton?

A. I know that Mr. Horton was there, because I found a letter which I wrote to him two days after this conference occurred, in which I spoke of it. In regard to Mr. Kuichling, I am inclined to think he may have been there, now, that you mention it.

Q. Who made any proposals at the opening of that conference?

A. The New York representatives.

Q. What were their proposals?

A. Well, there is a statement which I have, showing their ideas as to what New Jersey ought to do, in typewriting. Shall I read it?

Dr. O'Sullivan: Yes.

Witness (reading):

"Addenda Proposed to Specifications of Existing Contract Between the United States and the State of New Jersey and the Passaic Valley Sewerage Commission.

In order to secure the results herein specified and required, it is further agreed

(*a*) That the effluent from the sewage works of the Passaic Valley Sewerage Commission shall not contain more than the following percentages of suspended matters as compared with the crude sewage delivered to said works:

Up to and including the year 1920	40 per cent.
From and including the years 1921 to 1930	50 per cent.
After the year 1930	60 per cent.

1283 (*b*) That the effluent from said works before being discharged into the outlet tunnel and pipes, when mixed with two (2) equal volumes of distilled water at 70° F. saturated with oxygen, and incubated in a full and closed receptacle for sixteen (16) successive hours at 70° F., shall neither become putrescent nor shall exhaust the supply of dissolved oxygen in the original mixture.

(*c*) That there will be absence in the New York Bay and its vicinity of odors due to the Passaic Valley sewage.

(*d*) That there will be no injurious effect from said sewage upon floating and water-front property situated in the Harbor of New York.

(e) That the New York State Department of Health may have reasonable access to the sewage works of the Passaic Valley Sewerage Commission for the purpose of making such tests as may be necessary to determine whether or not the effluent from said works complies with the requirements of this contract.

(f) That no screenings, sediment, nor sludge from said sewage works shall be discharged into the waters of the harbor and Lower Bay of New York, nor at any point into the open sea beyond said bay, where the water is less than 10 feet deep at mean sea level and which is nearer than ten miles to any shore of the State of New York.

(g) That if the Passaic Valley sewerage District as now constituted shall hereafter be increased in extent, the degree of purification of the sewage of said district herein required shall be correspondingly increased."

Q. What was the object of that conference, Mr. Fuller, as you understood it?

A. It is stated in the record in this case; as I understand it, it was held with a view of seeing if technical representatives of the parties in interest could not get to some common ground,
1284 whereby negotiations might look promising enough to suspend the taking of testimony; that is, practically get some stipulated agreement for the termination of this suit.

Q. The hearings in this suit were suspended until an effort was made to secure some results from that conference?

A. I think that is so. I am speaking from memory, now, of reading last April the record. I think it is a fact that there was an adjournment on one or two occasions as the result of these pending or about to be arranged conferences.

Q. And at the time that that conference was held, you knew that there were no tests of any kind applied to determine the character of the effluent to be delivered into New York Bay, or the efficiency of the work of the Passaic Valley Sewerage Commission upon the Newark Meadows?

A. No, on the contrary, I knew that there were methods which had been in general use for a generation, and that they were adequate for measuring the reasonableness of performance of the plans set forth in these stipulations.

Q. Are any of those included in the stipulation?

A. I am now alluding to Complainant's Exhibit No. 135, being the stipulation between the United States Government and the State of New Jersey and the Passaic Valley Sewerage Commissioners.

1285 A. No, there is no direct reference to them. There is a reference to the dissolved exygen content, which implies that that test would be made. That is the one that certainly ought to be made, and I always believed should and would be made.

Q. Will you read the part of the stipulation that refers to the dissolved oxygen test as you have described it?

A. (Reading:) "The absence of reduction in the dissolved oxygen contents of the waters of New York Bay resulting from the discharge of Passaic Valley sewage to such an extent as to interfere with major fish life." That is the only reference that I see to what you might call a chemical test.

Q. And if the reduction of oxygen was found in New York Upper Bay after the discharge of the sewage effluent from the Passaic Valley disposal works, how would you determine whether that depletion was due to the Passaic Valley sewage effluent or not, under the test that you have just directed attention to?

A. It would have to be studied carefully in connection with a relatively large number of sampling stations, in order to get a relationship between its point of discharge and its zone of influence.

Q. How would any oxygen determination in the Upper Bay of New York give you any definite idea as to the condition of
1286 the effluent discharged from the Passaic Valley sewage disposal works?

A. You mean as regards dissolved oxygen content?

Q. Yes.

A. I can only suggest that there would have to be a sufficient number of sampling stations established, so that upon a determination of the dissolved oxygen at these various stations, there could be an opinion formed as to what the zone of influence would be surrounding this dispersion area around Robbins Reef Light. It is not a simple matter. It is not a question of taking one sample of the water and making a test of it and getting a right answer immediately, if that is what your question is directed to. It is not within the range of accomplishment.

Q. I asked you if you found oxygen depletion to a considerable extent in the Upper Bay of New York, how would you bring that fact home to the sewage effluent discharged from the Passaic Valley Sewerage Commissioners' works?

A. I can make no further answer other than there should be studied a zone of influence of that and other contributing volumes of sewage in large amounts.

Q. The Passaic Valley sewage would bear no tag on it that you could identify its injurious effects from?

A. No, I am very sure you couldn't detect it.

1287 Q. That is the only test that you know of that would be applied to the sewage effluent?

A. No, I explained in June that there are a good many tests that ought to be made at the plant to keep a record as to accomplishment and to serve as a guide in adequate operation of the plant. Those would be the total solid matters, the subsiding or settling solids; there would be the albumenoid of ammonia test, the oxygen consumed test, and dissolved oxygen test. Those are the principal ones that occur to me, beside studying out the amount of putrescible organic matter by such methods as are found most workable for the given conditions.

Q. Have any of the tests that you have just now enumerated been adopted by the Passaic Valley Sewerage Commission?

A. No, because for a very good reason—because they haven't any plant on which to operate as yet.

Q. Do you recall now that this conference was induced to lay down standards for the determination of the efficiency of the plant and the character of the effluent to be discharged from it, and where that determination would be made at the plant in order to determine its efficiency and the condition of the effluent?

Mr. Riker: The question is objected to on the ground that it does not appear that this witness knows the reason why this con-
1288 ference was called, as he merely has stated that he was a member of the conference, and on the further ground that it is not cross-examination.

Commissioner Maher: Note the objection of counsel for the defendants.

A. I do not know that that was the main purpose of the conference. It developed into one of the topics of conversation.

Q. And did you know on September 9, 1911, that the United States Government had no control over the discharge of that sewage and for the enforcement of the terms of that stipulation, unless it interfered by shoaling with the navigable body of water into which it would be discharged?

Mr. Riker: The question is objected to on the ground that it calls for a legal conclusion which is not within the scope of this witness's qualification.

Mr. O'Sullivan: The question is pressed for the reason that it does not call for a conclusion, but asks and requests his knowledge on the subject.

Commissioner Maher: Note the objection of counsel for defendants and the statement of counsel for complainant.

1289 A. No, I assumed that the United States Government would delegate such agent as necessary to find out what the facts were, if there was any doubt of the adequacy of performance of the Passaic Valley Sewerage Commission in the operation of its plant as stipulated in this document.

Q. Then as I understand, Mr. Fuller, on September 9, 1911, you knew that the Federal Government had the power to enforce this stipulation, even though it didn't interfere with the navigable condition of the body of water into which the Passaic Valley sewage would be discharged?

A. Why, I explained in June, I think at some length, all that I know about that subject. I know that the normal jurisdiction of the Federal Government with its tidal waters deals with interference with matters that will produce shoaling; but on the other hand, here is a proposition that we were—I say "we," the representatives of the State of New Jersey and the Passaic Valley Sewerage Commission—we were in repeated conferences with Colonel Black and representatives of the War Department, and I am sure we all took it for granted—surely I did—that if in the initial stages in the development of a project of this sort, they were so keen to exert their in-

fluence they certainly would not be less keen when it came to the performance of the actual plant.

1290 I stated that this country can take jurisdiction on these these special matters. They have in the past, and I will assume they will do it in the future. It is not under any special act of Congress which you apparently have in mind when speaking about the control of the United States Government on the shoaling of navigable waters. That I do know, and probably did know then, but I still maintain stoutly that I see no reason for assuming that the United States Government could not take jurisdiction in controlling the performance resulting from a plan, in the design and arrangement of which they took such a keen interest during those years 1909, 1910, and perhaps 1911.

Q. You say that the United States Government could enforce these stipulations?

A. That was my assumption then and it is now. I may be wrong; I will stand by the facts, whatever they can be established to be.

Q. And that was your belief on September 9, 1911, when this conference was called to determine the standard for determining the condition of the sewage effluent to be discharged into New York Upper Bay from the Passaic Valley trunk sewer?

Mr. Riker: The question is objected to on the ground that it contains a statement of fact which is not warranted, that is, the

1291 purpose for which this conference was called.

Commissioner Maher: Note the objection of counsel for defendants.

A. That is so, so far as I can remember.

Q. A year after that conference, in the year 1912, your book was published, Mr. Fuller, and I direct your attention to page 183 of the book entitled "Sewage Disposal," by George W. Fuller, published by McGraw-Hill Book Company in 1912, with a preface dated April, 1912, initialed "G. W. F." and direct your attention to page 183 of that work, from which I will read:

"The United States Government at present has no control over sewage disposal except in so far as sewage deposits relate to the shoaling of navigable bodies of water. (See Act approved March 3, 1899, and the supplement to the Revised Statutes of the United States, Vol. 2, page 994.) The above synopsis of the sewage disposal problem is taken with few modifications from a lecture delivered by the author on the principals of sewage purification at Cornell University in May, 1909."

Do I read correctly from your book?

A. Yes, sir.

Q. I now ask you, if that was your belief on September 9, 1911, that the United States Government had no control over sewage disposal except in so far as sewage deposits related to the shoaling of navigable bodies of water into which the sewage or the sewage effluent was discharged?

1292 A. I have answered that already to the effect that this is a true statement so far as relates to any general act, any act of Congress, but I don't believe now, and didn't believe then, that there is any reason why the United States Government, which had taken such a keen interest in this New York Harbor pollution, on reference by the Secretary of War to the Commanding General of the Department of the East, why they couldn't take it up at any time in the future from that date on. I still think so. Your question is directed as to whether the Government would take jurisdiction as a result of some act of Congress. As far as that act of Congress is concerned, they would not find their jurisdiction there, but that doesn't necessarily tie their hands, as I stated at great length in June, and try to make plain again now.

Q. Did you attend the hearings before the Harbor Line Board at which request was made for a permit for this trunk sewer outfall near Robbins Reef?

A. I did not.

Q. Did you read the minutes of the hearings before the Harbor Line Board?

Mr. Riker: The question is objected to as not cross-examination.

Commissioner Maher: Note the objection of counsel for defendants.

1293 A. I don't know; I presume I may have seen it, but not for a good many years.

Q. Do you recall that repeatedly the President of the Harbor Line Board directed the witnesses to deal entirely with matters that interfered with navigation or the navigable condition of the rivers and not on any sanitary or other questions apart from navigation?

A. I don't know.

Q. Do you know that the whole question involved as far as the War Department was concerned related entirely to questions of impairing the navigability of the Harbor waters of the Upper Bay?

A. That may be true, as far as some of the lines of inquiry of the War Department went, but it certainly was not true so far as the investigation instituted by Colonel Black, who had a good deal to say about his ideas bearing on the removal of organic matter and depletion of oxygen and putrescible matters and things of that sort.

Q. And his putrescibility test you disregarded in the formulation of these stipulations, did you not?

A. I don't know what it meant or how it would operate; neither did he or anyone else.

Q. And do you know now?

A. No.

Q. Do you know of its employment for any purposes for
1294 determining the pollution of waters?

A. It is used in determining the pollution—or rather the degree of purification of some filter plants, to see if you get a non-putrescible effluent or not.

Q. Will you describe the putrescibility test, so there will be no confusion as to what we are talking of, Mr. Fuller?

A. Within the range of my own observation and experience, the

putrescibility test consists in taking samples of treated sewage and putting them in a bottle and adding a chemical known as methylene blue; this is an analine dye. The resulting mixture of the effluent and the blue dye will remain blue so long as there is oxygen present, so long as it is a stable mixture. When the dissolved oxygen disappears, the blue color disappears and turns whitish. We do keep a record at a good many filter plants as to what is the length of time that a sample will remain in a stable condition; that is, whether at room temperature, it will remain blue for a period of a day or week or ten days; but that is a different matter, Dr. O'Sullivan, from what it is in dealing with a sewage which is simply subject to clarification. I don't know what the effect is of diluting sewage with certain volumes of aerated distilled water and things of that sort. I don't know that any test has been particularly standardized.

1295 Q. In your testimony in the month of June of this year, Mr. Fuller, I understood you to say that you didn't know that that putrescibility test was employed anywhere or that anybody knew anything about it?

A. Well, for conditions such as prevailed or would prevail here at the Passaic Valley Sewerage Commission project, I am inclined to reassert that view, or reaffirm it, but I am not by any means of the opinion that it has not been used at places where they have filtration plants. On the contrary, I know that it has been used, and used by superintendents working for me at a number of places.

Q. After discarding the putrescibility test prescribed by Colonel Black long prior to 1911, the matters that you have read now in relation to that conference, did they prescribe tests to be applied to the effluent itself?

A. You mean other than this putrescibility test?

Q. Including or rather restoring the putrescibility test.

A. In addition to the putrescibility test which I read from this memorandum there was also a paragraph bearing upon the percentage of removal of suspended matters from crude sewage.

Q. And these tests were to be applied to the effluent at the works?

A. Yes, it says "effluent from the sewage works of the Pas-

1296 saic Valley Sewerage Commission."

Q. And that was the burden of the discussion at that conference on September 9, 1911, was it not?

A. I think that was one of the principal topics of discussion, that and the putrescibility test, and the failure of the New York representatives to respond in any way to the intimation from the people of New Jersey that New York ought to come up to an equal standard for New York, as that we were advocating for New Jersey.

Q. When those tests were submitted to the New Jersey representatives, what position did the New Jersey representatives take towards those tests and their application?

A. I think the attitude was, in regard to the putrescibility test, that there was a feeling of uncertainty as to what it meant; that it was the same feeling that Mr. Humphreys, Chief Engineer of the London Sewerage System, expressed in the statement that I read this morning. It is a difficult matter to take a test that may have been

developed in a laboratory for some special purpose, and consent to its application to a very large enterprise. There was a feeling of conservatism and feeling of hesitancy undoubtedly on the part of Mr. Harrison and myself, to getting tied up to something we didn't know about.

Q. And as a result of that conference, no tests of any kind were agreed upon to be applied to the sewage to be discharged
1297 from the Passaic Valley trunk sewer?

A. Nothing was agreed upon, and the reason why no progress was made was what I have said repeatedly, that the New York representatives would not make any response towards their moving in the direction of adopting standards as high as they wanted to insist that New Jersey should adopt, through the stipulation with the United States Government.

Q. Had the State of New Jersey agreed to any test to be applied to the sewage effluent?

A. Not from a laboratory standpoint.

Q. From what standpoint?

A. From the standpoint of successful, practical performance, we had agreed to do what is set out in this stipulation.

Q. Are those tests as you understand them?

A. I should call them the most important tests; they are tests on a large working scale—yes, I call them tests, to answer your question directly; they are not laboratory tests, in the sense that you perhaps are carrying them in mind, and comparing them with putrescibility and suspended matter removals.

Q. And what you have described as tests are the appearances in the stipulation and the conditions to be found in the waters of the Upper Bay of New York?

A. Yes, I would call those tests; they may be specific ac-
1298 complishments. I am not using the word "test" now in a laboratory or restricted sense; it is in a broad sense of actual accomplishment in practice.

Q. In June of this year when you testified, Mr. Fuller, you were unable to give me the percentage of the work that you expected the Upper Bay of New York to accomplish in getting the result of what you have now described as the test of the conditions to be found in the Upper Bay of New York. Can you describe and give the percentage of work that you expect New York's Upper Bay to do in the clarification of this sewage to be discharged from the Passaic Valley trunk sewer?

Mr. Riker: With the exception of the fact that it is objected to on the ground that it is not cross-examination, I have no further objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. On the score of clarification I will discuss that in my answer from the standpoint of Mr. Eddy's assumption of 250 parts per million of total suspended matter of Passaic Valley sewage on an average. On a basis of removing 60 per cent, as can be removed

by the basins, as I have testified to, there will remain then 100 parts per million of suspended matter in the effluent going into
1299 New York Bay. Now, to make an unnoticeable amount of that fine suspended matter, so fine that it will not deposit in New York Bay, in the basins or anywhere else, it is necessary to get a dilution down to six or eight parts per million. You asked me what is the amount of work to be done in New York Bay as to clarification. That gives you the range and ratio. If you get a dilution of one in fourteen, you will bring that down to a point where you would scarcely notice the effluent of the Passaic Valley sewage disposal works if it were put into distilled water and you took up a glass and looked at it on clean table linen.

Q. What percentage of the work of clarification would you depend on the waters of New York Upper Bay to render by way of dilution?

A. That gives you the ratio of one to fourteen from the standpoint of getting this settled sewage so you cannot detect it in a clean drinking glass. This problem has many ramifications. It is a fact that during a large portion of the year the upland flow from the Hudson River containing the soil wash from some 15,000 square miles of watershed, some of which is swampy and produces a color or vegetable stain, you don't have to have dilution as high as a fourteen to one ratio, that I have spoken of for distilled water, because you cannot detect these very tiny nonsubsidable par-
1300 ticles in the effluent of the Passaic Valley sewage disposal works. You cannot detect them so readily in the turbid and colored Hudson River water as you can in distilled water, so that you can get along with a ratio considerably smaller than fourteen to one.

Q. Are you taking into consideration now the fact that the waters of the Upper Bay are heavily polluted as it is?

A. In what connection?

Q. With regard to your dilution answer.

A. So far as clarification is concern, why, that could be answered No, and that it should be taken into account; and if you take it into account, you would find a good deal of suspended matter going into the Bay Waters from sources other than the Passaic Valley sewers. I am speaking now of street wash other than the flow of sewers.

Q. How do you distinguish the turbidity in the Hudson River and in the Upper Bay of New York that is due to the alluvial washings, from the turbidity that is due to sewage pollution?

Mr. Riker: The question is objected to as not being cross-examination and not a topic touched upon on direct examina-
1301 tion.

Commissioner Maher: Note the objection of counsel for defendants.

A. The turbidity is noted in a practical way by people who are accustomed to seeing this Hudson River water at a long distance up the stream. I am familiar with it at Poughkeepsie and Fern-

croft. I have been connected with the Hudson River water in connection with water filter projects. I know somewhat in detail of it through the records kept at Albany. I know that where there is no opportunity for the sewage of the New York Metropolitan District to go, there is a very pronounced turbidity and color. The color is detectable in the New York Upper Bay. There isn't any doubt about that. The turbidity, that is a very difficult thing to detect, as to whether it comes from soil wash or from sewage.

Q. Have you read the testimony given by Mr. Stearns at these hearings?

A. Yes, some weeks ago I read it.

Q. Do you recall that he was unable to determine the turbidity that was due to alluvial washings from the turbidity that was due to sewage pollution?

A. I think he had difficulty; I think everybody would have difficulty in making the separation.

Q. How do you distinguish turbidity from color as ap-
1302 plied to water?

A. The way that is done practically in the laboratory is to put the water through very fine texture filter paper or through some pasteur filter—I guess I should say Chamberlain's filter—one made of infusorial earth as against clay which would not take out the vegetable. Water can be freed of this turbidity in that way and the color will pass through, and that does give you a chance to separate color and turbidity in the laboratory. Mr. Stearns was speaking from the standpoint of difficulty of the person in a boat, or a person who would look at a sample of water in a large container. There is real difficulty in telling the difference there.

Q. Do you recall that Mr. Whipple had the same difficulty?

A. Yes, and Mr. Whipple also told you what the relative colors and turbidities were from the sample he had last made, and he did, I think, separate some of those—some of those samples of water, the turbidity, in order to ascertain the color.

Q. In looking at the waters of the Upper Bay of New York from a boat, Mr. Fuller, how would you distinguish the turbidity that was due to alluvial washings, from sewage pollution, and from the presence of micro-organisms?

A. Micro-organism I would have to leave out of view; I don't know of any way of telling them by the naked eye. So
1303 far as the alluvial deposit is concerned, I think it is a fact that when the Hudson River is in heavy flood, it has a more brownish appearance than is the case when there is a relatively low flow from the Upper Hudson. The soil wash during flood periods entirely obliterates the relatively small turbidity producing effect of the sewage; if that is what you mean.

Q. During the freshets in the spring of the year in the Hudson River Valley, how would you distinguish between the pollution due to sewage origin brought down in the freshets from that of the alluvial washings also brought down from the upper reaches of the Hudson River?

A. I wouldn't try to do it; I think it is absolutely fruitless and hopeless.

Q. Is your memory quite fresh with regard to that conference on September 9, 1911, Mr. Fuller?

A. It is not beyond improvement, sir.

Q. Do you know at whose instance the conference was had?

A. No, I really cannot tell you very much about that. I think I was asked by Mr. McCarter to attend.

Q. And the matters that were taken up by the conference related to tests from the sewage effluent, to be applied at the sewage disposal works, was it not?

A. That is one of the things, as I have already stated.

Q. Mr. Fuller, did you examine—when did you examine
1304 the plant of the Passaic Valley sewage disposal system most recently?

A. Yesterday.

Q. Was it then you found the grit basins?

A. No, sir, when I first examined them, which was in April of this year.

Q. And did you find them of your own motion, or did they have to be pointed out to you?

A. I was probably taken to the head works and I was shown what there was to be seen beneath these piles that I have described. I am not trying to assume any special mental alertness in looking around there. I was shown what these structures were.

Q. And you looked through these ten-inch openings down into these basins, did you?

A. Yes.

Q. Where are those basins located, on the main floor or below?

A. Those are outside of the house entirely.

Q. Are they anywhere near the sedimentation basins?

A. No, they are on the other side of the pumping station.

Q. And you were able to measure approximately the length, width, depth and capacity of these grit basins, looking through that small aperture of ten inches?

1305 A. I could tell roughly about the depth. The structures are completed at the level of the surface of the ground. I made no attempt to tape them, but by inspection I am positive that they are substantially those dimensions. If anyone wants to tape them I am perfectly willing to have my testimony be marked up or down, as to the additions or subtractions. There are contract drawings which I have produced, and I looked over the drawings and looked over the work as built, and I am satisfied that they are substantially correct; that is, that the works are actually built substantially as shown.

Q. How did you distinguish the place that was set aside for the installation of these screens?

A. You mean the coarse screens?

Q. Yes.

A. I asked about them and had this plan, Defendants' Exhibit No. 10; I looked at this plan in my office within a few weeks. I had

looked at this plan, Defendants' Exhibit No. 10, and I looked at it last spring; I looked at it when I was here in Newark on Thursday of last week; I looked at it again yesterday before I went down to the works.

Q. My question was directed toward eliciting your answer as to how you located where the screens were to be installed, whether from the drawing or from your examination of what you have de-
1306 scribed as the grit basins which you saw through the small aperture in the wooden piles?

A. I perhaps didn't make my last answer clear. I should have stated that I saw where these coarse screens are shown on the drawings, and then when I went down there, I looked from the opening above, to see the groove where these screens will actually be placed. I did see the groove yesterday where these large screens will be attached in front of the grit chamber.

Q. Will you describe those openings that you saw where they expect to install the screens?

A. It is simply a groove——

Mr. Riker: One moment; the question is objected to as not being explicit, the witness having testified that he saw the place where the coarse screens were to be installed, as distinguished from any other screens.

Commissioner Maher: Note the objection of counsel for defendants.

Dr. O'Sullivan: Read the question.

(Last question repeated.)

A. You mean coarse screens, Doctor, or fine screens, the ones in front of the grit chamber?

Q. We are discussing the grit chamber, Mr. Fuller; is there more than one set of screens in the grit chamber?

A. There are none in the grit chamber; there is one set of
1307 screens, which I call coarse screens in front up stream from the grit chamber, and then in the screen house, which is located between the pump room and the grit chamber, there are the fine screens.

Q. Will you describe the coarse screens that are higher up, as you described it, than the grit chamber?

A. As I saw those yesterday, there is nothing there but a groove in front and up stream from the place where the stop planks will be inserted. Those coarse screens are not built and they will consist of bars, rectangular bars, which I was informed will be placed about two inches apart. That is as far as I can go with you on that.

Q. Do you recall that you made no allusion to these bar screens in your testimony in June last?

A. I don't remember.

Q. Where are the fine screens located?

A. There are no fine screens built, but the grooves in which these semi-fixed cage screens will be located, are to be seen in the floor of the screen house, which is located between the pump room and the grit chamber. I am looking now at Defendants' Exhibit No. 10.

Q. Will you describe those fine screens, Mr. Fuller?

A. They have not yet been built; bids were received in the late winter of 1918, and the contract drawings show that they are
1308 of the cage type of screens; that is, there are bars, vertical rods, three-quarters of an inch in diameter, staggered and attached to a frame which can be lowered down into the sewage and raised up again, to allow the sewage matter to be detached. These bars on the contract plans show the spacings, as I have already explained at some length, of one-eighth of an inch, as you look in the direction of the flow; the actual tangential distance is one-half an inch between rods on the contract plans, and I am informed by Messrs. Brown and Taylor, that it is perfectly agreeable to change them as shown in yellow on this Defendants' Exhibit No. 11, which would make the openings four-tenths of an inch; that is all in the future. There are no screens built at present.

Q. You have now described the fine screens?

A. Yes, those are the fine screens.

Q. And those screens are larger than the screens stipulated for, are they not, in Complainants' Exhibit No. 135, in the openings?

A. They are very much smaller. If you look at this one-eighth inch dimension in the line of direction of sewage flow, as is shown here on this Defendants' Exhibit No. 11, it is a fact that it is larger in the ordinary blue print dimension of a half inch, but it
1309 is equal in its tangential distance, if you consider the figures shown here, in yellow ink, four-tenths of an inch.

Q. These screens also differ from the stipulated screens in Complainant's Exhibit No. 135, in being hand-cleaned and not of the revolving type, is that so?

Mr. Riker: The objection is made that the question embodies as a fact, a matter which has not been proved; there is no evidence to indicate that the screens required by the stipulation are revolving screens.

Commissioner Maher: Note the objection of counsel for defendants.

A. The stipulation speaks of self-cleansing mechanical screens. It is a fact that the screens which the Passaic Valley Sewerage Commission proposes to build are of the type which will have to be lifted out of place and cleaned after they are lifted to the floor above this screen chamber. There are two sets in each of those three chambers, the purpose being to have one set down in the flowing sewage, while the other is being elevated to allow the matters retained by the screen, to be detached and taken away for ultimate disposition.

Q. While you state that there are two sets of screens, would there ever be more than one set of screens in use?

Mr. Riker: The question is objected to on the ground that
1310 the witness is asked to guess as to what the operation of this plan will be.

Commissioner Maher: Note the objection of counsel for defendants.

A. My view is that there would always be the coarse screens at the inlet of the grit chamber, and these fine screens for the sewage to flow through after leaving the grit chamber and on its way to the pumps. Now, whether out of these six different fine screens the sewage will flow through one or six, or any intermediate number, I cannot tell It is perfectly feasible to have five of those six fine screens in service practically all the time.

Q. Do you make that answer from studying the drawings or from any direct knowledge that you have gotten from the chief engineer of the Passaic Valley Sewerage Commission?

A. I am just using common sense, knowing that these different arrangements are actually built, and assuming that they will be availed of in a reasonable manner.

Q. I direct your attention to the testimony you gave in June, from the record, page 18, of the stenographer's minutes in this case, and particularly to that part of it which states: "These screens are hand cleaned screens and not screens of the revolving type." Do you recall giving that testimony on your direct examination?

A. Yes.

1311 Q. And that they are not screens of the revolving type?

A. They are not screens of the revolving type.

Q. I continue my reading from the point that I stopped: "That is not a literal compliance with the provision of the stipulation, but it is my opinion that it would produce an equal amount of clarification." Do you recall giving that testimony on your direct examination?

A. Yes.

Q. What do you understand by revolving type of screens, Mr. Fuller?

A. Well, there are various revolving types of screens; I presumably had in mind in June the facts that are set forth in the correspondence with the War Department in securing that approval which is set forth in Defendants' Exhibit No. 12, and which correspondence shows in considerable detail about this so-called Hamburg screen, which correspondence appears as Defendants' Exhibit No. 12A.

Q. Those are revolving screens, were they not, the Hamburg screens?

A. The Hamburg screens are revolving screens, yes.

Q. And the screens that are outlined in the stipulation known as Complainants' Exhibit No. 135, in these hearings were modeled on the Hamburg type, were they not?

A. I understand so; I have never seen those drawings, that

1312 I recall. I mean the drawings that are referred to by Chairman of the Passaic Valley Sewerage Commission, when he addressed his letter to the War Department, asking for a modification. I have been told that that is a fact.

Q. Mechanically cleaned screens are usually revolving screens, are they not?

Mr. Riker: The question is objected to as immaterial and irrelevant.

Commissioner Maher: Note the objection of counsel for defendants.

A. Perhaps generally so, although it is possible to get a raking arrangement where the cleaning rake would be the moving part and not the screen.

Q. Do you know where what you have just described is in operation now?

A. I think so; at Manchester, England.

Q. And that you regard as exception in the mechanical cleaning screens not being of the revolving type?

A. I think the majority of the screens move themselves. I think perhaps the safer statement would be that both the cleaning arrangement and the screens themselves, all the parts, are movable.

Q. How many sets of screens are contemplated now by the Passaic Valley Sewerage Commission?

1313 A. There is the coarse screen at the inlet of the grit chamber, and there are the sets of fine screens in the screen house between the pump house and the grit chamber. Do you want me to recite the total number of screens, Doctor?

Q. No, I asked you how many types?

A. There are two types. There are stationary screens, these coarse screens, above the inlet to the grit chamber; these are bar screens which will have to be cleaned in place by raking the detached separated matters up onto the platform, as shown on this drawing, Defendants' Exhibit No. 10.

Q. In your recommendations for improving the operation of the plant and its efficiency, I understood that you recommended a third type of screen, did you not, in June of this year?

A. I described a third screen for emergency use, if and when necessary. I certainly would not think of installing it until after the plant had been put in service. I don't think it will ever be necessary if this plant is well operated. It is all a question of the fidelity with which the deposit is detached from these hoppers on the floor of the sedimentation basin, and detached with such frequency that putrefation can be avoided.

Q. And there the personal equation largely enters into the

1314 operation of the plant, does it not?

A. Yes, for this and every other plant.

Q. And by introducing hand cleaned screens rather than mechanically cleaned screens, you increase the personal equation and the liability to inefficiency, do you not?

A. I think that is pretty debatable. The hand cleaned screen, if not cleaned, of course, will show itself with the depths of sewage that you could get in the trunk sewer; that is, can dam up the flow of sewage, if these fine screens at the Newark Bay pumping station are not cleaned at fairly frequent intervals; that is a fact. If you have a mechanically operated screen, if everything goes well, it will operate. It will not do as good work, because you don't get the clogging effect and the lessening of the space between the bars. But here is a thing that my experience prompts me to speak of, with a

good deal of seriousness, and that is, in the last few years the mechanically operated screens in this county have not been successful, because you cannot make the things operate more than 80 per cent or so of the total number of hours in a year. We had a very fine screen, for instance, at Reading, Pennsylvania, in front of a sedimentation tank, and we found it was with the greatest difficulty that we could get that in operation more than about 80 per cent
1315 of the time. Finally we abandoned it entirely and found that the sedimentation basin did just as good work and just as good a quality of effluent left the sedimentation basins before as after the screens were installed.

Q. What is the population of that place—Reading, Pennsylvania?

A. It is a town of approximately 100,000 people.

Q. Are you familiar with the operation of the Reinsch Worl screen?

A. Yes, I have seen quite a number of plants of that type.

Q. Have you read Mr. Kenneth Allen's testimony in this case as to the operation of the Reinsch Worl screen at the Dyckman street plant?

A. Yes.

Q. As to the efficiency of those so-called fine screens that you have described, Mr. Fuller, does the age of the sewage determine that in any particular?

A. It is something of a factor, yes, sir.

Q. How much of a factor?

A. I really don't know how to answer the question. I know that if sewage has flowed over a considerable distance with high velocities there is a tendency for it to become comminuted, and that means that the particles are less readily held back, or held back in smaller proportion, that would be the case before this comminution
1316 or subdivision of solid matters occurred. That is offset by the measure of the program for frequency in the cleansing of these screens.

Q. Would screens with a half inch opening hold back much material when the sewage is comminuted and septic?

A. They held back in Boston more per thousand population than the Hamburg screens did. That is a big system, that South Metropolitan sewer system.

Q. How old is the sewage at Hamburg when it reaches the screens?

A. I am not able to tell you from memory.

Q. How old is the sewage at Boston when it reaches the screens?

A. I don't know; I don't carry them in mind. At Hamburg, the screen that I have seen on a good many occasions, is on the east side of the river, where the great bulk of their million population is resident.

Q. Isn't it a fact that in proportion as the suspended matter is finely divided, the screens are less serviceable in removing that suspended matter?

A. I don't know just exactly what you mean by "serviceable". They will not remove as much per thousand population, but they will remove all there is to be removed of a certain size.

Q. If the particles are half inch in size, would you call it
1317 comminuted—would you call the sewage comminuted?

A. I don't know how to answer that, really. It might be so and it might not.

Q. Will you describe, Mr. Fuller, what you mean by comminuted sewage?

A. The comminution of sewage is the expression applied to sewage which has flowed in a sewer under conditions where the original suspended particles have been broken up, or disintegrated physically. That is a question that involves a degree; I don't know how to discuss it very wisely.

Q. How are the particles in septic sewage as to their wholeness or comminution?

A. I imagine they would not be in their original wholeness. I don't think those things cut any figure, though, in the lay-out such as they have here in Newark, where the sewage will go through a settling basin, following the action of screening. I base that on this experience I told about, at Reading, Pennsylvania. The elimination of fine screenings cut no figure at all in the quality of the effluent leaving the sedimentation tanks.

Q. Screening would be of very little service if the sewage is in an advanced state of decomposition and finely comminuted; is not that a fact?

A. That might be so, but I am aware of the fact that the
1318 great bulk of the population in this district is in the Newark district, which is adjacent to this plant.

Q. What percentage of the contributing sewers in Newark are flat grade?

A. I do not know.

Q. How many miles of them are of flat grades?

A. I could not tell you.

Q. What is the highest grade in the Passaic Valley trunk sewer?

A. It is sufficient to produce a velocity of over four feet a second. I can give you those grades, if you are interested in them. It is about 7/100ths per cent. That is the maximum grade. The velocities when running three-quarters depth, range from 2.84 at Prospect street, Paterson, to 4.05 as the trunk sewer enters the pumping station. Those are lineal feet per second.

Q. What is the slope of the trunk sewer at Prospect street station, taking 1000 feet as the unit?

A. That would be 0.7 of one foot per thousand.

Q. Are you positive that it is as much as 0.5 of a foot per thousand feet?

A. This slope is given here as 0.0007; if I said 0.7 of one per cent. I should have said 0.07 of one per cent.

Q. Take the Hope avenue, what would the slope there be per
1319 thousand feet?

A. I cannot tell you; I could look it up.

Q. Would it be half as great a slope as you found at Prospect street?

A. It would probably be a flatter slope, because it is a larger sewer,

but the velocity would be higher. There is one very important thing to notice in the trunk sewer velocities in this Passaic Valley project; that is, that they are lowest at the upper end of the trunk sewer, and progressively become higher as you reach the pumping station at the foot of the trunk sewer.

Q. Do I understand you to say that the grades are highest nearest the pumping station?

A. The velocities are greatest. Of course, the sewer is bigger and the grades are flatter, that is a fact, but the velocity is higher; it becomes over four feet per second.

Q. Doesn't the slope of the trunk sewer greatly diminish, until at the pumping station it is approximately one-half the slope that it is at Prospect street?

A. I think that is true, sir, but with the difference between a sewer at the pumping station of 12½ feet in diameter and a sewer at Prospect street 3 feet 9, the velocity of flow is higher at the lower end.

Q. Even though there are a large number of contributing
1320 sewers of flat grade, would that be so?

A. I don't see how that bears on the proposition; I am speaking of the slope to the trunk sewer itself.

Commissioner Maher: Note an adjournment until 10.30 tomorrow morning.

1321 Continuation of Testimony in the Foregoing Cause, at the Office of Messrs. Riker & Riker, 164 Market Street, Newark, New Jersey, on Friday, September 12, 1919, at 10:30 A. M., Pursuant to Adjournment.

Present: Counsel as before stated.

GEORGE W. FULLER resumes the stand for further

Cross-examination.

By Dr. O'Sullivan:

Q. What was the grade of the slope at the Prospect street station, Mr. Fuller, giving the slope per thousand lineal feet?

A. It is 0.07 of one foot per thousand.

Q. And does the slope steadily decline from that until it reaches the pumping station where it is zero?

A. Yes, there is a generally progressive decrease in the slope of the invert of the sewer, but it does not become zero; the slope continues until the pumping station is reached; at the pumping station the slope is practically 0.3 of a foot per thousand, and in that connection, as I stated yesterday, it should be borne in mind, that with the increasing size of the trunk sewer, there is a progressively increasing velocity from Prospect street, in Paterson, down to the pumping station.

Q. You used the expression, yesterday, Mr. Fuller, of a "good grade"; will you describe what you mean by these terms?

1322 A. I mean a grade that will produce a scouring velocity. And to particularize on that, I should say that the grade should produce a velocity of two feet and a half per second. I don't mean, now, that that would be the velocity every hour during the 24; at night, of course, there is a lower flow; but that that velocity should be obtained at some time during the 24 hour period.

Q. And as to the degree of the slope, what degree of slope would give you that velocity and would come under your definition of "good grade"?

A. That would depend materially upon the size of the sewer. A velocity of 0.3 of a foot per thousand feet, for instance, in the sewer as it reaches the pumping station 12 feet 6 inches in diameter, that will produce a velocity of 4.06 feet per second. Of course, to get that velocity in an 8-inch sewer, you have got to have a slope of, I should say, 4 feet per thousand, or ten times as much. Intermediate between the 12 foot sewer and 8 inch sewer, there is a relationship that can be figured out.

Q. Does the size of the sewer solely qualify that question in your mind of good grade, or would the volume of sewage in any way qualify it?

1323 A. It is, of course, necessary to have sewage flowing in reasonable quantities, and reasonable in proportion to the capacity of those several-sized sewers which I have mentioned.

Q. Now, as to the size of the trunk sewer, what is the diameter of the trunk sewer at Prospect street?

A. It is 3 feet 9 inches.

Q. And it increases steadily in size, does it not, until it reaches the pumping station, and will you give the size and diameter of the trunk sewer at the pumping station as it reaches it?

A. Its diameter is 12 feet 6 inches, and the increases in size come at designated intervals; that is, it is not a uniformly increasing tapered sewer, but, for instance, say 3 feet 9 to 4 feet 9 at Lawrence street, in Paterson, and then at various distances down the line it will increase in diameter.

Q. What is its diameter at Berlin street?

A. That is in Paterson—I don't see that diameter on the 40 or 50 different listing which I have as to location.

Q. On my blue print, Mr. Fuller, I have it 13 feet 6 inches; do you know if that is correct?

A. It is not correct with regard to the sewer as built. I take it that you are speaking of deductions made from perhaps the 1908 drawings. I am speaking of, and have before me, data obtained

1324 from the contract drawings showing the structures as actually built.

Q. Is the diameter of the trunk sewer at any part of its length greater than 12 feet 6 inches, and if so, where?

A. No, it is not greater than 12 feet 6 inches.

Q. And the computed capacity of that trunk sewer is 357,000,000 gallons per day, is it not?

A. That is estimated capacity—maximum capacity.

Q. Now, these conduits by which you contemplated dividing the sewage flow into three parts, how large would those conduits be?

A. In the sedimentation basin, my proposition dealt with two sets of cross walls; one of them I called an influent conduit, and the other an effluent conduit. The dividing wall containing the effluent conduit would have a waterway 3 feet 6 inches in width and 4 feet 6 inches high; it is an oval shaped conduit, very similar to the conduits built there at the present time, as the main inlet to the existing basins.

Q. How would these connect with the trunk sewer, if at all?

A. These are on the discharge side of the trunk sewer, of the pumping station; the sewage will be lifted after it passes through the coarse screens, the grit chambers; the fine screens could then be lifted by the pumps to an elevation roughly 25 feet above ground level, just as it is today with the basins as they now stand.

Q. How powerful would these pumps be, Mr. Fuller?

1325 A. I don't know what the horse power is; they are every-day pumps; they have a capacity of about 100 million gallons per 24 hours, three of them now being installed.

Q. At what rate of velocity would you expect the pumps to send the sewage into one of those conduits?

A. Whatever was required by the volume of sewage to be handled.

Q. About what velocity; have you any estimates in relation to the approximate velocities even?

A. I should say offhand, without making any computation, it would be in the general vicinity of a 4 feet per second; it might be quite a bit more than that at times of storm flows.

Q. Is that rate conductive to sedimentation?

A. No, there wouldn't be any sedimentation in those conduits.

Q. At the discharge point of those conduits would not you get 4 feet per second in the velocity?

A. It is possible that there would be obtained a velocity in that general proportion or dimension.

Q. And would that facilitate or retard sedimentation?

A. Well, it would simply mean that the laws of subsidence would not become fully operative until that inlet velocity has been checked, and that is why I suggested in my testimony in chief yesterday, that in front of those sluice gates there would be

1326 placed a board or baffle wall, which would rest on posts, which might be, say, 4 feet square, that would stop the force of the entering velocity to which you are referring. You are speaking, of course, I now take it, with regard to the entering velocity through the sluice gates attached to these conduits. That can be arrested in this way that I speak of, putting the baffle board directly in line with the entering flow; that would cause the entering stream to be deflected, part of it going above and part below, and part either side of this baffle board. That is a very common arrangement in tanks of this sort.

Q. How would the sluice gates themselves be operated, Mr. Fuller?

A. They are shown here with a hand wheel at the top of the wall, where the operator can walk around and get access to them.

(Defendants' Exhibit No. 13.)

Q. They would be operated by some person in connection with the plant?

A. Yes. This Defendants' Exhibit No. 13 where I have shown in yellow pencil, the sluice gates would be the same size, operated in exactly the same way as shown in the white lines on the original blue print. I will point out further that through the
1327 original conduits there would be sent by this proposed rearrangement only one-third of the volume that would go through these conduits and sluice gates if they were to be operated as originally intended.

Q. But each one-third would go at a higher rate of velocity than the original volume, according to the contract plans as they are now?

A. No, each one-third would go at a lower velocity; the conduits are actually built at the end next to the pumping station; instead of taking three-thirds, it will now take one-third of the flow, whatever that may be in varying periods throughout a term of years.

Q. How do you diminish the velocity?

A. You have the same cross sectional area. This main influent conduit, for instance, is oval shaped; it has a width of 3 feet 6; that is horizontal dimension; its vertical dimension is 6 feet 6. That opening as actually built is fixed, and if you put one-third the volume of liquid through it, the velocity is bound to be one-third as great.

Q. Even though the rate of pumping is maintained at the same—

A. I don't know just exactly what you mean by that
1328 question. I am assuming now that if you take any given pumping rate for the entire flow of the sewer, you will get that ratio of one to three; I don't quite see the bearing, perhaps, of your question. The purpose that I have in making this suggestion is to keep these velocities down, and the entering velocities you speak of can be controlled in this way that I have designated.

Q. Without changing the rate of the pumping?

A. These pumps will be operated at varying rates, they will have to meet the actual flow; there isn't any doubt about that. There is no such thing as a fixed rate of pumping and the pump falling off radically in its efficiency; these are not electrically-driven pumps, they are steam-driven pumps.

Q. With a steam-driven pump, and at the same rate of pumping, a smaller volume would be sent with a higher velocity than three times that volume, would it not?

A. I don't grasp that at all. The steam at the throttle would be adjusted to handle whatever flow came to the pumping station.

Q. I say with the same rate of pumping. Your answer would now incline me to believe that one-third of the volume of sewage could not be sent at a higher rate of velocity than the entire vol-

ume, which would be three times that, at the same rate of
1329 pumping?

A. I think the misunderstanding is due to me having assumed, and perhaps you not having assumed, that as many of these basins would be put in use and kept in use as are necessary to meet those requirements. That is the fact as regards what I am assuming, and I think that if you would assume the same, it would eliminate this difficulty or uncertainty in your mind.

Q. These dividing walls that would be built, in order to divide the sewage volume into three parts, they would reduce the content capacity of the basins themselves to three per cent, would they not?

A. Yes.

Q. What advantage would that be, Mr. Fuller?

A. That wouldn't be any advantage; it wouldn't be any measurable disadvantage, though. What that means precisely is this: that this effluent conduit would call for a wall about three feet thick, and instead of having 72 feet length of travel, for instance, you would have 69 feet. That applies to one of the two cross walls that would have to be re-arranged; in the other case there would be no change.

Q. Mr. Fuller, directing your attention to these emergency screens, these fine screens that you recommend for catching
1330 the gas-lifted sludge, would these screens, according to your recommendation, be stationary or revolving screens?

A. I think that they would be probably moving screens—the revolving screen; that is what they had at Atlanta and at Baltimore.

Q. They have the same kind at Columbus, Ohio?

A. No, those were stationary screens.

Q. Which gave the best results, the ones at Atlanta or the ones at Columbus, Ohio?

A. The ones at Atlanta had absolutely nothing to do; they only had about a wheelbarrow and a half load of material to take away in a year and a half.

Q. And what was the population of Atlanta as compared with the population of Columbus, Ohio, and as to the character and nature of the sewage and the trade waters treated in both places?

A. Now, at Atlanta I will have to state again, that there are three disposal plants, and this particular screen that was installed was at what is called Proctor-Creek plant. The population there tributary to the sewer was originally about 30,000, and perhaps is 40,000 to 45,000 now. Atlanta had a population of, I should say, a little under 200,000 people, but there are two other plants which
1331 I am leaving out of view, in my answer to this question. Atlanta is not a manufacturing city, it is a commercial city.

Columbus, in the days when I was officially connected with that work, had a population, in round number, of 200,000 people, and had a rather more concentrated sewage, with some trade wastes. That is an industrial city, but not one that has in any way an appreciable amount of textile industries. It is a metal working town.

Q. I understood you to say yesterday, Mr. Fuller, that the mesh of the fine wire screen used at Atlanta was about 24 to the inch?

A. Yes, sir.

Q. That would be for the opening about what fraction of an inch, approximately?

A. I don't know; I presume the opening itself would not be more than half of that; it is a small opening.

Q. 1/48 of an inch?

A. Perhaps something like that. I don't recall exactly that the gauge was of the wire; it is practically a wire cloth; that is what it is.

Q. And dealt almost entirely with domestic sewage, did it not?

A. Very largely with domestic sewage. The practical proposition is there, whether the solids that have once been deposited in the sedimentation tank will stay put. At Atlanta they did stay put.

1332 At Baltimore and Columbus and in earlier years they did not stay put in hot weather.

Q. How did you account for that peculiar bacterial activity that brought that sludge to the surface in Columbus as against the more Southern city, Atlanta?

A. The biological activity was not the controlling element at Atlanta. These are what they call two-story tanks; they have a hopper bottom and the sewage—I don't mean a hopper bottom, I mean they had a sloping bottom, at the foot of which was a slot, and they slid down then into a digesting chamber beneath the slot. There was no trapping effect at Columbus; they were single story tanks with a flat bottom. The sludge was allowed to accumulate for weeks and months. In warm weather the gasification did lift the solid matters at intervals into the flowing stream and appeared at the outlet. The trapping was the difference.

Q. Before that sludge became sufficiently buoyant to float, it had already undergone biological disintegration as sewage, and what condition would you now expect it in, as scum or gas-lifted sludge, as to its consistency?

A. That is a function of several factors, one of which is the amount of the entrained gas; the other is the adhesiveness of the particles which would allow the massing together, to confine the gas, so that the whole body would be floated. It is not completely decomposed or disintegrated. It is in process of decomposition, and it cannot be completely disintegrated; otherwise, it wouldn't have

1333 adhesive properties, such that it would produce these large patches of gas-lifted sludge.

Q. The mesh of the screen at Columbus, I understood you to say, was ⅛ of an inch; is that correct?

A. That is my recollection.

Q. And 1/48 of an inch at Atlanta?

A. In round numbers that is roughly right; it was a brass cloth.

Q. Does the temperature of the sewage have anything to do with the buoyancy of this gas-lifted sludge?

A. Not to any appreciable extent that I know of.

Q. Can you give me an idea of the temperature of the sewage at Columbus, Ohio, in June, July, August and September?

A. I can look it up in my book; I can tell you offhand what I

carry in mind. It is 70 to 75 degrees, I should say. If you want it correctly, I will look it up in my book.

Dr. O'Sullivan: No, that is sufficient for me, Mr. Fuller.

1334 Q. What would you expect the temperature of the sewage of the Passaic Valley trunk sewer as it reached the outlet at Robbins Reef to be?

A. I have no reason to believe that it would be different from that essentially at Columbus.

Q. Do you know whether or not the sewage at Columbus, Ohio, was particularly rich in nitrates and nitrites, and whether or not these facts in any way influence the embarrassments occasioned by the gas-lifted sludge to those who operated the plant?

A. I am very sure those were not elements of practical significance. The most extended analyses made at Columbus were during the period when we operated a testing station. At that time the city derived its supply from a very highly mineralized ground water, and in later years, beginning, I think, with the operation of the large sewage disposal works, they had a surface water supply, and it was very materially softened, also.

Q. With regard to your suggestion for blowing air into the intercepter and into the contributing sewers, will you give me a little more detail as to the methods you would recommend?

A. I have already stated that in great detail. The thought that I had outlined in my mind was to have an electrically-driven—
1335 motor-driven—blower, air compressor, that would allow air, I will say at five or eight pounds, to be distributed through a perforated pipe system. Such an arrangement could be located near some convenient manhole, and the discharge from the compressor would lead the air into what might be called a header, that would be put into the sewer, very likely attached to the top of the sewer. Then at intervals from that air pipe header, there could be dropped smaller pipes, which in turn would have perforated pipes lying on the floor of the sewer.

Q. Would that air have to be blown in continuously?

A. It is not imperative that it should be blown in. The thought conspicuously in my mind is that air would be applied at such intervals as would prevent the sewage being devoid of oxygen. In other words, it is a correction of the depletion of oxygen in the trunk sewer, and by that I mean to say a practical means is afforded of stopping bacteria getting over to that anaerobic or putrefactive basis for decomposition.

Q. If that air was not blown continuously and these perforated pipes were lying on the floor of the sewer, what is there to prevent their being clogged up and rendered inefficient?

A. There are two answers to be made to that; one is, just as we find in actual experience with the activated sludge
1336 method of purifying sewage, it is possible to put on a higher pressure of air to blow out accumulations; the other feature that is resorted to is, that at intervals it might be necessary to have

to go in and take out these pipes, if they should become very seriously clogged.

Q. Would you follow the same line of distribution for those pipes in the contributing sewers?

A. No, the contributing sewers, the lengths are relatively shorter and the grades in the greater portion of this Passaic Valley sewer district are relatively high, and I think that the prevention of putrefactive conditions there can readily be handled by well-known procedures for keeping sewers clean. I mean by that, it would be a much less difficult undertaking here in this Passaic Valley than is found actually to be necessary to put into effect at New Orleans. That is an almost absolutely flat city, and it has been necessary to develop working procedure which will actually stop the stranding of solids in all the sewers, in fact.

Q. Taking the flat-graded sewers in the city of Newark; would you install these aeration pipes as you have suggested you would in the intercepter?

A. Not unless it is necessary. If 40 or 50 years in the future it should be found necessary, I believe that I would do it. You are referring in your question to the intercepter and in Newark,
1337 and not to the collateral lines?

Dr. O'Sullivan: That is right.

Q. How, then, would you obviate putrefactive changes in the flat-graded sewers of Newark?

A. By following procedures such as have been followed in New Orleans, as a general answer. I can detail that, if you wish.

Q. Yes, I wish you would, Mr. Fuller.

A. I will tell you what they do at New Orleans. They have in their larger sewers these flush gates, or flushing manholes; they consist essentially of a shear gate, which is a sluice gate such as shown on this Defendants' Exhibit No. 13, except that it is a hinge gate, and a handle is provided extending up into the manhole, so that that can be closed and then opened very readily. They close one of those gates and allow the head of sewage to build up, that is, the depth of sewage. That is suddenly released, and that allows a velocity to be produced that will scour out deposits for quite a number of hundred feet. I do not want to give you the impression, Doctor, that one shear gate would allow a corrective elimination of stranded solids to be brought about over miles or even thousands of feet of sewer in length. It is necessary to have those at—I presume we find
1338 them at intervals of perhaps—depending on the velocity—six or eight hundred feet, ranging up to perhaps 2,000 feet. There isn't any cure-all by doing something at one end of a collecting sewer, and have it effective for the entire distance.

There is one other thing which is done at New Orleans, which I believe I have not mentioned in any detail in my testimony here, and that is, they put in a wooden ball in those sewers themselves. It is known by the operators of the sewage disposal plant as an operation of giving sewers a pill. If a sewer has a diameter, we will say, of 18 inches, it is the custom to put in a round wooden ball; its diameter

may be 15 inches or 12 inches, and that is attached to a cable; that is put into the upper end, and it will itself create a damming up of the sewage in part. This in turn produces a head that will scour out the deposit between the wooden ball and the bottom of the sewer. This wooden ball will float, of course, and the space which it does not occupy is located at the bottom rather than the top of the sewer. Those are the two arrangements resorted to at New Orleans perhaps most frequently. The thing that they do, also, is where they have a drainage canal conveniently located, they have a connection where they can divert storm water, when there is water in drainage
1339 canals, for flushing purposes, out beyond the reaches of the drainage canals and their city water works plant. There have been times when they have taken water in carts, during yellow fever epidemics and things of that sort, but the two main features are the use of the flush gates and this wooden ball.

I assume that what I have described at New Orleans and know about personally could be applied at Newark in these relatively flat-graded sewers lying east of the Pennsylvania Railroad tracks. I am absolutely positive of the fact that there can be worked out and put into regular working schedule whenever required, a procedure to stop the stranding of solids. That has not been done regularly in America. It is one of the great shortcomings of sewage practice here as against European practice. It has been done in Europe and can be done anywhere else.

Q. It is not possible to discharge the sewage of New Orleans at high tide?

A. No, New Orleans is situated at an elevation below the level of the Mississippi River. All of the sewage is pumped by pumps that are very closely similar to those here at the Newark Bay pumping station. It is the same type of pump. There are a great many auxiliary pumping stations in New Orleans.

Q. How high up would you install the aeration devices for
1340 preserving, as you have stated, the sewage in the trunk sewer of the Passaic Valley Sewerage Commissioners.

A. I have stated in my direct examination that I had in mind locating it somewhere at the lower city line of Paterson, but that is perhaps a less comprehensive answer, than to say that it should be installed at a point where the facts as determined in future years would show us real need for it. There is no reason why it cannot be moved higher or put lower down. The thing to be kept clear in mind is to put in the air at such a point as it found need for correcting a depletion of dissolved oxygen.

Q. You stated you would use the aeration recommendation made by yourself as a preservative and not as an oxidizing agency; is that correct?

A. I think I made that statement, yes.

Q. How can it preserve—the air injected after the fashion that you have testified to, if it does not oxidize, either directly through chemical union or indirectly through biological agencies?

A. I suppose in a highly technical sense, it would be an oxidation, but it wouldn't be a direct oxidation in the sense that organic matter would be converted into nitrates or completely oxidized substances. What would actually take place is, that the bacteria
1341 would decompose the sewage into simpler substances, and it would do it with the aid of the aerobic bacteria and not the putrefactive bacteria. Nitrogen, no doubt, would be converted to the ammonias. It wouldn't be converted to what I call oxidized nitrogen, that is, to nitrates.

Q. When you used the term nitrates, did you mean to use "nitrates" or "nitrites," when expressing the avidity for oxygen and direct chemical union?

A. I don't remember just the reference which you have in mind. I mean that there would be no nitrates produced, that is, complete oxidation of nitrogen substances. In nitrites, of course, there is an intermediate substance.

Q. Which has the greater avidity for oxygen?

A. I don't think either one will grasp oxygen.

Q. When nitrites chemically unite with oxygen, what do they form?

A. Nitrates, but that cannot be done by molecular oxygen, such as you get out of the air; it has to be done by biochemical activities, or by some other extraordinary powerful chemical or oxidizing agent.

Q. When anaerobic bacteria disintegrate organic matter into these elements that have an avidity for oxygen and direct chemical union with oxygen, do they pass into solution in the surrounding liquid?

A. In some measure they do, and in some measure they
1342 are gaseous elements.

Q. Some enter into the gaseous state and some into the condition of solution; is that right?

A. I presume that is generally right. We know about gaseous elements, but we don't know much of anything about the ones in solution. I presume there are those substances in solution.

Q. If you do not know, then why did you state in your direct examination that it would not be necessary to oxidize the liquid itself?

A. I was speaking of liquid in the sense of the spent water supply which makes up the great bulk of the flowing sewage in the sewer. It is not necessary to oxidize the organic substances in the liquid portion of a sewage, the soluble matters in it; in fact, it is anaerobic action causing products in soluble form. It is my view that in the application of this process which I have proposed, they would not be allowed to form. That is the very point that I want to make thoroughly plain. The air would be applied so that they would not be formed, and in that way putrefactive odors would not be established.

Q. Will blowing air into anaerobic putrefactive organic matter induce aerobic action?

A. Yes, if it is done for a long enough period of time.

Q. How long a period of time would it be necessary to
1343 blow air into the putrefactive or septic sewage of the Passaic Valley trunk sewer in order to induce aerobic action, where anaerobic action was active and pronounced?

A. That suggests a situation that never would occur if this process were applied, and I have stated repeatedly the anaerobic or putrefactive process would not be allowed to become established. Of course, if that should be found to be the situation, it shows that either the location or other elements in the arrangement as actually apply, would need correction.

Q. You made a parallel for your aeration recommendation in the aeration scheme for the Catskill or the Croton Aqueduct waters—potable waters. I ask you how the aeration is conducted of the potable water supply that comes from the Croton Aqueduct?

A. There is no aeration in the Croton Aqueduct. You mean the Catskill?

Q. I now ask you about the Catskill.

A. It is done by means of aerating fountains; that is, the water is sent through nozzles under the head that will allow it to come up 12 or 15 feet above the surface of the water in the basin and throw a spray in the air.

Q. And it is a continuous process?

A. No, sir, it is used when necessary, and not otherwise.

1344 Q. And what is the object of that aeration of the potable water supply that comes from the Catskill Aqueduct?

A. In the first few years of the use of that water supply, the purpose was to eliminate the odors of putrefaction which arose from anaerobic conditions appearing in the bottom waters—in the water which came in contact with the more or less swampy bottom of the easterly arm of the Ashokan reservoir. Those putrefactive conditions, of course, have gradually improved as the years have gone by.

Q. Is there any parallel between the system of aeration employed in the Catskill Aqueduct potable water and the one that you suggest for the aeration of the Passaic Valley trunk sewer sewage?

A. I think in my direct examination I was using the Catskill project as illustrative of the intermittent phase; that is, to be used when necessary, but not otherwise. The difference, of course, in the method of application, I have already explained.

Q. As to your recommendation for the flushing of the intercepter and the contributing sewers, are there any additions that you wish to make as to the recommendations which you have given already and testified to in your direct examination?

1345 A. I think I ought to make it plainer that I haven't in mind any flushing arrangement whatever in the intercepter itself. Its velocities are such, with the grades actually used in the construction of that trunk sewer, that there is no need of it. It is possible, of course, to vary the rate of pumping so that there might be some deposition, but that could be corrected by increasing the velocity to get a scouring velocity, just as in the case of Boston and Hamburg and other places. But at Hamburg there are about two and a half hours during the tidal cycle when they cannot get

a gravity flow of sewage into the River Elbe, and the sewage is allowed to accumulate in the sewers, and when the tide falls, the tidal gate is released and the sewage is swept out at a velocity that takes with it the depositions.

Q. Are these flush gates used anywhere where sewage can be discharged by gravity into tidal waters or into the ocean?

A. The same situation actually arises at Hamburg, but they are not using flush gates at the outlet. That is a tidal gate. But they do use in Hamburg flush gates, and they also use, with great success, this wooden ball arrangement. In fact, the use of that wooden ball originated more than fifty years ago at Hamburg.

Q. Is it used in Florida now?

A. The wooden ball?

Q. Yes.

1346 A. No, that is sluice gate or shear gate that is used.

Q. But in Florida and New Orleans and these other places where it is used, they have very flat grades, and the gravity discharge is only possible at certain stages of the tide; is that right?

A. No, they are flat grades, and my office has kept pretty actively in touch with a good many of these problems through the effort of local authorities to avoid the use of pumping stations.

At New Orleans I suppose there must be at least a dozen different pumping stations. The town is almost absolutely flat, and the grades there are about 25 per cent flatter than they are anywhere else in this country that I know of, as a regular thing. That is over a whole system of 600 miles of sewers.

Q. As to your recommendation in relation to varying the pumping rate, Mr. Fuller, to what extent would you diminish the pumping rate at any stage of tide by your recommendation, if it was adopted?

A. I haven't in mind any regular program. I thought, as I think I testified in June, that the rate of pumping might be cut down to one-half or perhaps less. I haven't in mind cutting it down to 10 per cent or anything like that. There could be, however, a substantial reduction in the pumping rate, and the thought

1347 I had in mind was, to bring about a smaller volume of entering sewage at the dispersion area during the period when there was a smaller volume of bay water moving over that area.

Q. Would you expect sedimentation in the tunnel sewer during that diminution of the pumping rate?

A. Oh, no, I certainly would not, because the velocity would never be lowered to anything like as small a velocity as would obtain in the tanks through which the sewage would pass before entering the tunnel leading out to New York Bay.

Q. How deep is the base of the tunnel from the disposal works themselves, about?

A. I really don't remember, Doctor; it is a 12-foot tunnel.

Q. Yes, but its depth?

A. You mean below the floor of the bay?

Q. It presupposes a certain number of feet, does it not?

A. Yes, it does. I have seen those profiles, but I don't remember them.

Q. About how much?

A. I wouldn't attempt to guess.

Q. 100 feet?

A. No, I don't think so; I don't think it is that deep; I don't know.

Q. How high does the tunnel sewer rise before it reaches
1348 the point of outlet at Robbins Reef from the base of the tunnel sewer?

A. I cannot tell you that; I haven't any plans to which I can refer.

Q. How then can you state that by diminishing the pumping rate one-half, that you can get enough velocity to force the contents of that tunnel sewer through and not encourage sedimentation?

A. I wouldn't lower the velocity to a point where you would get into that predicament, and I certainly would keep the velocity in excess of the one-half inch per second which is written into the stipulation. It would be very much more than that. I looked up yesterday the velocity, pumping at about half the capacity, and it was about 1.6 feet, which is a heap of difference between a half inch and 1.6 feet. How far below the 1.6 feet in the direction of the half inch per second it would prove advisable to go, I will not attempt to say. That is a problem for the operating forces when the plant goes in service. I am indicating a principle that you can take advantage of without doing any harm, and a workable one, at that.

Q. In varying the pumping rate, I understood you to testify that you would vary them in accord with the velocity of the tides in the Upper Bay of New York; is that so?

A. That was my thought, yes.

1349 Q. Are those variable or constant factors, the velocities of the tides in the Upper Bay of New York, both at the surface and at various depths below the surface?

A. At the surface they are subject to currents and elements that are perhaps of a special nature. At the bottom, I should assume that wind and factors of that sort would have much less effect. My idea was that the operating force would establish at that structure, at the terminus of the outfall sewer a few hundred feet from the dispersion area—that the responsible executive head of that operating organization would station a man there and have a tide gauge; he would have current meters for detecting velocities; he would have telephonic communications with the Newark Bay pumping station, and after a reasonable period he would develop what might be called a regimen of these periods of low velocity of flow of the bay water over the dispersion area. I am aware of the fact that it is a thing that cannot be evolved out of the head of any person by sitting in an office. It has got to be treated as a working proposition. There is no reason why that cannot be done.

Q. Do you believe that feasible?

1350 A. I believe it is feasible to do it in a reasonable way; I don't think it is best to set up an absolutely inflexible working program, that a man could put into effect a written order on the

first day of January and feel that it wouldn't have to have some judgment displayed in using that order in interpreting it during the year. But it is a generally a helpful proposition, that is practical to adopt, if it is found necessary to do so.

Q. Do the currents vary with the depths very perceptibly?

A. I presume that they do somewhat, more particularly in the upper reaches than in the lower depths. Whatever the facts are, they would have to be stated and correlated and allowed to take their proper place in the listed regimen of procedure to which adjustment would have to be made.

Q. Taking the flood currents in the Upper Bay of New York at 4 feet, at 20 feet and at 40 feet, how would they differ as to their velocity?

A. They would differ quite a little. They are shown in Mr. Allen's chart—I cannot tell you from memory, Doctor.

Q. But there is considerable difference, is there not?

A. There is some difference; I don't consider it is enough to destroy, by any means, the reasonableness of the statement that
1351 I have made, that all of those things can be studied out in a workable manner.

Q. Do you know that the Metropolitan Sewerage Commission had made considerable investigation covering some years in order to determine these velocities of tidal currents in the Upper Bay of New York?

A. Yes, they also made use of the method of having a float submerged to different depths and had a cord about 100 feet long attached to it, and then they would throw that out from their mooring place, and detect some knowledge as to the practical behavior of the currents in that way. All those things are capable of study in connection with this particular dispersion area.

Q. And are very variable, are they not, from day to day?

A. No, I think not, as regards the lower velocities around the dispersion area itself, that is, where the nozzles are located 40 or 50 feet below the surface of the water.

Q. Take the flood current, is that more rapid 40 feet below the surface or at the surface?

A. I really don't know.

Q. What difference would spring tides make in these currents as above the currents found in ordinary tides?

A. I am not carrying that information in mind at all. I can only say that the facts should be developed and let them take their proper place in the regimen of conditions to which the operating pro-
1352 gram should be adjusted.

Q. And in order to advise those who would alter the rate of pumping, I understood you to say that you would install current meters near the dispersion nozzles; is that right?

A. I think that they would give information of some interest. It would be one of many things that could be done. I am speaking, of course, in connection with the use of current meters, to throw light on what I have gathered in reading the record in this case, and that is, for about a half hour or so, each side of the so-called turn of the tide, the velocities would become less than normal.

Q. And as to the reading of these current meters, you would have an observation post at Robbins Reef with telephonic connection that would communicate that data to the sewage disposal plant on the Newark Meadows; is that right?

A. That could be done. I had thought of giving more attention at the outset to developing what I call the regimen; that is, find out the performance or behavior of those currents. I would list the departures from the normal. That information is not capable of detection in a day or two or month. This project is one of such magnitude that it would have to have, I take it, a good wide-awake
1353 business administration. A man at the head of that organization would do these things I have suggested, and no doubt many other things. They would reflect themselves in his orders and instructions to his actual operating man.

Q. Have you submitted these elaborate recommendations to any of the Passaic Valley Sewerage Commissioners?

A. No, sir, I have talked them over with the chief engineer and his two deputies.

Q. Do you believe that the man who operates an extensive system of that kind is as important as the plant itself, in the recommendations you are making?

A. No, I wouldn't say that, but I should think that the best results from the operation of the plant require intelligence and fidelity on the part of the management. There is no doubt about that.

Q. Are you familiar with Mr. Thresh's experience in London and throughout England, where he emphasizes that fact, that the man who operates a sewage disposal plant is as important as the plant itself, no matter how well designed?

A. I am in sympathy with that thought, that a well-built plant can produce very poor results through neglect or incompetence or wilful disobedience of orders.

Q. There are very many sewage disposal systems in operation in the State of New Jersey?

1354 A. Quite a number.

Q. Various systems are employed in different areas?

A. Yes.

Q. Do you know that the general experience in the operation of those plants is as set forth by Mr. Daniels, who for many years, under the State Department of Health, had the function of inspecting these plants

A. I cannot tell you from memory just what is stated in his book. I have talked things over with him a great many times. I think he has a feeling of discouragement, that the local officials felt that sewage disposal works in small towns in New Jersey were not particularly a popular place in which to spend public funds.

Q. And that the more you introduced the personal equation, the more unsatisfactory the results; is not that so?

A. That might be so. I wouldn't say that that is true in all cases. I certainly have a great deal of respect for the fidelity of a good many of the Jersey authorities.

Q. Have you read Mr. Daniel's book, Mr. Fuller?

A. Yes, but not in quite a number of years. There is no doubt but what there are places in New Jersey, like every other state, where sewage disposal works are neglected and are supposed to be operated by superintendents of highways, whose interests naturally are
1355 more in keeping highways in repair than in keeping sewage disposal works in a good state of operating efficiency. That isn't universally true, though.

Dr. O'Sullivan: If you will read this work, I think you will conclude that it is.

Witness: I have had a good deal of experience myself in New Jersey in operating sewage disposal works. I am not trying to get behind Mr. Daniel's knowledge. I know something about it myself.

Q. While these pumps are being operated at half their pumping rate, how would you prevent deposits at points above the pumps?

A. I don't think it is important to prevent them. The thing is to create velocities that will scour them out at sufficiently frequent intervals. They would occur just as they do in Boston and Hamburg when the flow is completely checked. The flow in the main outfall sewer at Hamburg is checked of necessity by tidal gates for 2½ hours in each tidal cycle. In Boston, at Nut Island, there is a gate lowered once a week with the deliberate intent of building up a head in order to scour out deposits. Deposits do not constitute a menace to the proper operation of sewers. It is the absence of scouring velocities that is the element of control.

1356 Q. Mr. Fuller, when sewage is dammed up in either a contributing sewer or in this great intercepter of the Passaic Valley trunk sewer, how does the fluid move after the obstruction is removed, from the top, or middle or at the bottom?

A. The velocity would be higher at the top than at the bottom, but what that ratio would be I cannot tell. It would depend on a great variety of circumstances.

Q. I am trying to get at how you get your scouring velocity, when the surface liquid moves faster than it does at any other part of the dammed sewage?

A. I will only say in response to that, that it is a fact that these deposits can be swept out. You have to get a velocity on the bottom of the sewer where the deposits are, around 2½ feet per second, or thereabouts. It may be that if it was a five-foot velocity, at the surface when you first released the dam, the thing to do is to get a scouring velocity at the bottom. Experience shows that that can be done.

Q. How do you get that? That is what I mean; by the dammed sewage itself?

A. You have to get a head with sufficient velocity to bring about that scour. I am talking about actual accomplishments rather than the theory of the thing.

1357 Q. Then if you can get the velocity that will scour these sedimentary matters and stranded solids, why did you recommend flushing in addition to the pumping of the sewage; why did you recommend the flushing of the contributing sewers and of the intercepter?

A. I may perhaps have given too much weight to it. That is one way of accomplishing that purpose, but it is expensive. Pressure water comes to be quite an item of expense. It is used in some cases. It is also possible to get it by diverting water from brooks and things of that sort. I know that you can flush out these deposits. I studied sewage at Plainfield where they have screens that will allow the sewage to build up several feet above its ordinary level. Then when the screens are cleaned you get a scouring velocity. We get into no difficulty, provided we get a velocity of 27 or 28 inches per second. That is practice. It is the art, perhaps, rather than the science on the subject. It is a practical accomplishment that I am trying to describe.

Q. Now, as to chemical precipitation. I understood in your direct testimony yesterday, Mr. Fuller, that you had considerable knowledge with regard to the chemicals found in the trades wastes of the Passaic Valley communities; is that correct?

Q. I don't remember of having stated it in that way. I said that I had some experience at a couple of the large textile indus-
1358 tries in studying their waste products. I don't think any man, outside of the chief dyer, knows all of the chemicals that go in there. No one is allowed to know those things, but I do know that they have a wide variety of chemicals. I know from practical experience in trying to clarify and purify those waste liquids, considerable about their behavior.

Q. Will you name some of the manufacturing plants that discharge trade wastes containing chemicals, along the Passaic Valley and into the Passaic River at present?

A. There are silk dyeing establishments at Paterson and there are wool dyeing establishments in Passaic. There are, of course, quite a number of metal working establishments.

Q. Taking the metal working establishments, do you know anything about the spent liquor or pickling trade wastes as you described them yesterday?

A. I know that there are here in Newark, and I think to some extent in the upper portion of the district there are metal working establishments where they do use—dilute acids to get a bright clean metal surface. I cannot tell you from memory what that volume is, but I have no hesitancy in saying that it is practically a small one that can be ignored. In earlier years my firm sent an assistant to practically every industrial establishment in the valley, and
1359 we did ascertain as far as possible what the general character of waste products were from industrial establishments, and approximately the volume of such wastes. Pickling acids are not a disturbing factor in the Passaic Valley trunk sewer project.

Q. What do they consist of, chemically?

A. *Unu*sually a dilute sulphuric acid.

Q. What chemicals do you recommend for the chemical precipitation that you suggest with regard to the treatment of the Passaic Valley sewage?

A. I should say offhand that I would try first lime and sulphate of iron, but I don't want to give the impression that it would have to

be limited to those. It is a question of finding out what the actual behavior of the sewage is at that time, in the more or less distant future, when the need may arise for applying chemical treatment.

Q. Yesterday I understood you, Mr. Fuller, that you recommended ferric sulphate and aluminum sulphate; is that correct?

A. I have stated in my testimony about the use of sulphate of alumina and sulphate of iron. The latter would be the ferrous and not the ferric iron. It would be the cheap sulphate of iron that is manufactured at various steel works, and such as used in the
1360 purification of water for many of our large cities. It is not a drug store product, which I understand the ferric sulphate of iron to be.

Q. How would the pickling liquid containing sulphuric acid from the iron works of the Passaic Valley affect the ferrous sulphate that you would use in chemical treatment for chemical precipitation?

A. Three thoughts come in my mind. In the first place, this Passaic Valley Sewerage Commission will not allow any extraordinary or injurious quantity of acid to go into this trunk sewer. It would disintegrate the trunk sewer itself. That means that at the works themselves there would have to be built storage tanks to be released slowly to allow the spent acid to be released slowly to the trunk sewer. If that is done there is lime and manganese in the sewage itself and the acid would largely, and perhaps wholly, neutralize in that way. If acid in small quantities should reach the Newark Bay works of the Passaic Valley Commission, and ferrous iron is added without lime, it would interfere with the amount of work precipitating action accomplished by a ton of that product. And what is done in practice is, to adjust the amount of lime added at your treatment plant, to overcome any irregularities of that sort. The
1361 difficulties of operating a chemical precipitation plant for this Passaic Valley trunk sewer is mere child's play as compared with the difficulties of operating a chemical precipitation works at Worcester, which have been actualiy operated for nearly thirty years. There are the pickling acids released by the large wire works there that is a dominating factor of the whole sewage. It is not true here.

Q. You get a very large variety of chemicals in the trade wastes of the Passaic Valley, do you not?

A. Yes, I think that is true.

Q. Taking the type of manufacturing that you have just spoken of a few moments ago, the silk industries of Paterson, do you know how many plants there are there altogether dealing with the treatment and manufacture of silk?

A. I am not very well informed about that, no; there are quite a number, I know. It is one of the biggest silk dyeing sections in the world.

Q. 200 plants?

Mr. Riker: The question is objected to on the ground that it is not cross-examination on the rebuttal testimony introduced through this witness, but is merely further cross-examination on the
1362 main testimony of this witness.

Commissioner Maher: Note the objection of counsel for defendants.

A. I don't think there are anywhere near that number.

Q. I direct your attention to Defendants' Exhibit No. 2, under the heading "Industries having trade wastes, Paterson, New Jersey," the third item, "Silk and silk goods, including throwsters, 276 establishments; total persons engaged, 20,099." Does that accord with your memory on the subject?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I cannot tell you anything about it from memory; I know that there is a very large industry in Paterson. I know there have been a good many consolidations of smaller mills united into the bigger mills. I will be guided by the facts, whatever you show them to be.

Q. In cutlery, do you know how many plants there are manufacturing cutlery in Paterson?

Mr. Riker: The question is objected to on the ground that it is not cross-examination on the rebuttal testimony introduced through this witness, but is merely further cross-examination on the main testimony of this witness.

1363 Commissioner Maher: Note the objection of counsel for defendants.

A. No.

Q. Do they use sulphuric acid and discharge it as spent liquors or pickling liquors?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I presume they do.

Q. Can you give me an approximate idea of the number of manufacturing plants that discharge chemical trade wastes in the Passaic Valley region, Mr. Fuller?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. No, I cannot from memory. I studied those things a good deal in earlier years, but not recently.

Q. Would that be necessary before prescribing the chemical precipitants to be used by the Passaic Valley Sewerage Commissioners?

Mr. Riker: Same objection.

Commissioner Maher: Note the objection of counsel for defendants.

A. I tried to make plain that lime and sulphate of iron will do this work. I adhere to that position that those chemicals are
1364 the one most rationally to be used. So far as actually fitting their detail application and getting a working program devel-

oped, I wish to make it plain that that is a thing for the future. This trunk sewer isn't in existence. When it is in existence, I don't think it will be necessary to use chemical precipitation, but if that time in the future should arise, it is a part of the duty of the responsible management to work up all those details and to consider their effect; take the composite situation as found at the pumping station and work out a program which is manageable and effective. That can be done absolutely.

Q. Why was chemical precipitation rejected by the London sewage authorities in their treatment of sewage of the City of London?

A. Because they found that plain sedimentation without the use of chemicals gave an adequate result. That is what I tried to point out plainly here would apply, in my judgment, to the Passaic Valley project with reference to New York Bay.

Q. If sedimentation in London was sufficient for their purposes, why did the sewage authorities there purchase 720 acres to biologically treat the sewage, which you say was efficiently treated by sedimentation?

1365 A. Because the views at a period fifteen or eighteen years ago, held by the former chief chemist, were given more weight at the time of the land purchase than is thought to be prudent at the present time. They spent a great deal of money in testing biologically means for purifying sewage. That has all been wiped off the slate. The land purchases stayed.

Q. They rejected biological processes?

A. They determined definitely not to adopt them, and that goes back to the period of about 1900. They did use chemical precipitation each month of the year beginning in 1891 and 1892 on until 1911. They did find in 1911 and 1912 that it was not necessary to use chemical precipitants, that plain sedimentation gave a result which was satisfactory. That takes it up to the period of my personal knowledge. I was last there with Sir Maurice Fitzmaurice, the chief engineer of the London County Council in 1912. His official reports set out what I have discussed with him and what I stated, and his successor, Mr. Humphreys, seems to hold that view, as described in his lengthy discussion which I read into the testimony yesterday, and which view of Mr. Humphreys is of date February, 1917.

Q. Do you approve or disprove of biological processes for

1366 sewage treatment, Mr. Fuller?

A. I think it is all right where it is necessary to be used.

Q. Were you connected with the Baltimore plant?

A. I served as a substitute for Mr. Hering when he was in Europe. I have had a good deal to do with the Baltimore project one time and another. He was a member of a board of advisory engineers—Mr. Gray, Mr. Stearns and Mr. Hering, and I sat in his place in 1905, and I think again in 1908.

Q. Do the biological processes of sewage treatment in Baltimore yield satisfactory results?

A. They do except as regard the odors. They have had a great many suits filed against them on account of odor production. So

far as results in the so-called back river, an arm of the local bay there, the oyster industries, I think the plan is considered a successful one.

Q. In your opinion is it successful in its biological process for the disintegration of sewage?

A. This odor production—the lawsuits which the city has lost in defending these suits makes it a debatable question in my mind as to whether you can call it wholly successful. I am inclined to believe that it is not as successful as the state of the art would indicate to be desirable.

Q. Could those odors be obviated by improved conditions
1367 or approved appliances?

A. That is a pretty big question to answer. I imagine they could be modified and lessened.

Q. What biological processes are you familiar with for the disintegration of sewage and its treatment rendering it innoxious?

Mr. Riker: The question is objected to as being immaterial, irrelevant and not cross-examination, and not within the scope of the order of March 10, 1919.

Commissioner Maher: Note the objection of counsel for defendants.

Dr. O'Sullivan: The question is pressed for this reason: this witness predicated his testimony on these very biological processes with regard to the Thames River and the deposits there and the treatment of the sewage.

A. I am troubled to know what you mean by your word "disintegration."

Q. What do you mean when you use that term, if you do?

A. I don't use it.

Q. It is a new term to you, Mr. Fuller, disintegration, as applied to sewage?

A. I am almost inclined to say Yes, sir. I would suspect that disintegration would be almost a synonym for comminu-
1368 tion, but I may be wrong.

Q. Then I will frame my question this way: what biological processes are you familiar with that are employed for the treatment of sewage and reducing it to harmless or innoxious elements that can be discharged with safety into the tidal or other waters?

Mr. Riker: Same objection as the last objection made.

Commissioner Maher: Note the objection of counsel for defendants.

A. Innoxious—do I understand that you make drinking water out of the treated sewage?

Q. They can make drinking water out of sewage, can they not, and give you an effluent which is capable of being drunk without detection of either odor or taste?

A. Yes, the Paris sewage farms in earlier years allowed a result at very great expense to be obtained in that way. As filtration pro-

cesses decrease in cost and the rates of flow of the sewage through the sand or other filter matter increase, you get farther and farther away from the drinking water standpoint. The sewage farm idea has never been successful in this country. We have too heavy rainfalls, and even in our southwestern states, the inevitable result is that the operators of sewage farms, when the rainy periods come,
will divert sewage into the nearest ditch and not take in onto
1369 their farms for irrigation purposes. I think you can see
that that method is a failure; in this country, conditions are different than they are abroad.

In London, you spoke about biological arrangements that were studied there. They did state that the use of coarse grain filter beds—they are sometimes spoken of as contact beds—Professor Clowes, he was the chief chemist of London County Council for a term of twelve or fifteen years prior to 1900—he studied those various arrangements called contact beds and found he could purify something like half a million gallons of sewage per acre, as I recall, and upon his retirement, his successors deemed that that was a needless expense. In fact, it was not considered within the financial limits of the London metropolitan district. The idea was abandoned. They went on with the chemical precipitation until 1911, and went to plain sedimentation, which was not the program laid down by them for governmental authorities back in 1882. Of course, there are other kinds of biological treatment, for instance, the sprinkling filters, such as they have in Baltimore.

Q. How about the Imhoff tanks?

A. The Imhoff tanks are not as satisfactory an arrangement,
in my opinion, for a big project, as the tanks that are being
1370 built by the Passaic Valley Sewerage Commission. They
are very bad actors at intervals, with respect to odors—the Imhoff tanks; at Baltimore their use has been abandoned.

Q. Are you familiar with the Miles treatment of sewage?

A. Not from practical experience; I have read reports about it; I know its shortcomings.

Q. What are they?

A. The principal shortcoming as applied to an industrial community is that the acid will cause a separation of oily products, whether they are animal or mineral origin. When the grease is recovered and the animal fats are mixed with lubricating oils used around machine shops and the like, it is found that its salability drops so low, that it throws entirely out of reckoning the economics as we have read of them in small test layouts. It is not in operation in any place in this country, but on a test scale, and I don't know of any of those now in service.

Q. Are you familiar with the experiments along that line on a large scale at New Haven, Connecticut?

A. I call this a small scale. I have talked them over with my associates on the teaching staff at Yale University.

Q. What volume of sewage is treated there by the Miles
1371 process?

A. None whatever; that work was entirely closed down.

Q. Are you quite sure?

A. It may have been taken up again. It was surely closed down in April and May, 1918. A report appeared in the early spring of this year. The chemist in charge of it has gone to Chicago and is now serving the Chicago Sanitary District. They may have had a successor to Dr. Mohlman; if so, I do not know it.

Q. In accounting for the depletion of oxygen in the 2,814 determinations represented through Professor Phelps, I understood you to account for them by three elements, or factors, that you would consider, and that the first was, the variation in dredging; is that right?

A. I didn't intend to give quite that impression. I was desirous of pointing out three elements other than those Professor Phelps has spoken of.

Q. Of those three, I think you spoke of first the variation in dredging; I understood you to use that expression, the variation in dredgings?

A. Yes.

Q. What ratio exists between the amount of dissolved oxygen found in the waters of the Upper Bay of New York and the quantity of dredged material that has been taken from it?

A. I don't know; I don't think anyone else knows. It is
1372 an element that I spoke of as accounting for fluctuations as against a depletion which would progressively point towards 100 per cent depreciation. I think that these elements that bring about fluctuations and irregularities are entitled to most careful consideration; that is, the fluctuation, meaning departures above and below the progressively decreasing line of depletion. You have got to consider the factors each side of your medium line, or resultant line.

Q. In the figures which you gave yesterday, which you stated were the summaries of the dredgings for the past fifteen years in the Upper Bay of New York, what percentage of that dredged material included the material that was taken out of the Ambrose Channel?

A. I am unable to tell you. Ambrose Channel has not been in process of actual dredging on an extensive scale for some years, as I recall, but I am not able to tell you the details in that regard.

Q. What amount of that dredged material was represented by rock taken out in the deepening of Hell Gate?

A. I don't know anything about that.

Q. Have you included in that summary the dredgings down by the City of New York in its slips and other parts of its water front?

A. If they are reported by the chief of engineers, they are
1373 included here; if they are not so reported, they are not. I am taking the reports of the Chief of Engineers of the United States army as he gives them.

Q. And were those taken out by the national government or by private individuals or by the City of New York?

A. It is possible that they are limited to the work of the Federal Government.

Q. In addition to that summary, can you give me any approximate

idea of the amount of dredging material removed by the City of New York from its water front?

A. No, I am not informed on that in detail. I know that they do do dredging around some of their slips.

Q. In addition to that summary, can you state the amount of material that has been dredged by private individuals at docks and wharves and other parts of the water front property?

A. No, I am not informed about that. I am aware of the fact that the New York Dock Company—if that is the name of the corporation that controls the private docks lying on the east side of the East River and North of Erie Basin—I know that they have been in the habit of dredging out considerable material from the slips. I am under the impression that the dredgings have been materially lessened during the period of the war, and not only as regards the performance of the Federal Government, but also
1374 the New York Dock Company, or whatever the name is of the private corporation owning this line of docks north of the Erie Basin, and also the City of New York. It has been a period during the war of markedly less activity along all these lines.

Q. And during the war period has the shipping increased very markedly in the Port of New York?

A. Very markedly, yes.

Q. Are you aware of the fact that the small river known as the Harlem accommodates more shipping than any seaport on the Atlantic seaboard except Philadelphia?

A. No, I am not informed about that.

Q. Are you aware of the fact that Newtown Creek accommodates more shipping in value than the Mississippi River?

A. No. I have seen reference to it in the testimony as I read it in this case, but it is not a subject within the range of my personal knowledge.

Q. The second element that you wished to consider in discussing Professor Phelps' oxygen determinations, was the irregularities or inequalities of oxygen loss in sludge. What are those irregularities and inequalities of oxygen loss in sludge?

A. I mean this, that where there are sludge deposits, those of an organic nature are subject to putrefaction as it goes on and
1375 they are subject to liquefaction and gasification. That is not a process that goes on by direct biological activity for the most part, because while there are some forms of life that will eat those sewage solids directly, it is the liquefaction and gasification which will produce the so-called sulphuretted-hydrogen substances that do rob the overlying water of oxygen. Those products are not produced directly by biological action; they are produced indirectly. That is, the bacteria under certain conditions will excrete a liquid formation. They are spoken of as a form of substances known as enzymes. Those enzymes are what bring about the liquidation and gasifaction of sludge. Enzymes and these liquid products—products caused by liquefaction and gasification—those do rob the overlying waters of oxygen. There are a markedly irregular institution, as we see it, in the operation of sewage works, and I am convinced it is

true to a very substantial degree of the sewage sludge deposits in any harbor. I mean by that, that if we should have a series of six septic tanks, or five, nine or whatever number you choose—I am carrying in mind quite a number of plants now where the tanks are in various subdivisions—it is an absolute fact that some of those tanks will work more regularly than other tanks. It is true that other tanks
1376 will work less satisfactorily than the average behavior of the plant. It is also true that plants with various sludge digestion compartments will show irregularities in the particular compartments which behave best for a given season. Compartments that are best in their sludge digestion arrangements for one year, will not necessarily be best the next year. My practical observation on sludge digestion convinces me that that is an important element. It is true of all sludge digestion. It is true of the sludge deposits in New York Bay, for those deposits are being decomposed and produce gases which rob the water of oxygen. If they are behaving like tank No. 2 at Plainfield, for instance, they will supply oxygen in a certain ratio. If they are behaving like tank No. 6 at Plainfield, they will have a different relationship to that oxygen. I think that illustrates, Doctor, the principle.

I want to make plain that there is no regimen of procedure when it comes to considering the effect of those sludge deposits upon the robbing of oxygen in the overlying waters. It is subject to caprice and irregularity. It fluctuates.

Q. You stated that enzymes were excreted. Will you state postively that they are not secreted?

A. They are caused by bacteria living and producing cer-
1377 tain products. I will submit that as a fact; and the way in which it is produced—biologically, physiologically—I am not very wise in that line; I will accept whichever is the better word in your judgment; it is the accomplishment that I wish to lay stress upon.

Q. You recognize distinctions between excretions and secretion, do you not?

A. Yes, I will take it either way.

Q. Which is an enzyme, a secretion or an excretion?

A. I am rather bothered to answer that; it is a product coming from the bacteria, and in that sense I have used it as an excretion. If I am wrong, I will stand corrected. I can see easily as you suggest the word, the physiologist would probably say "secretion".

Q. Do some ferments act directly and some through their enzymes?

A. No. I guess we are misunderstanding each other. The bacteria produces enzymes, and they bring about fermentation. Sludge deposits are decomposed in part through fermentation caused by bacteria. In fact, so far as bacterial action is concerned, it is my judgment that that is the chief way in which the sewage solids are decomposed. I presume they do eat some food material in order to thrive. That I am not aware of. But I am of the opinion—in fact my book on sewage disposal relates experiences which
1378 I had personally some twenty-five years ago, which lead me

clearly to the belief that the bacteria directly get their food in a soluble state; they don't act directly on the sludge.

Q. Do anaerobic bacteria secrete or excrete enzymes?

A. I will say that they move in their cycles, the same as the other bacteria. Let my earlier answer apply to this.

Q. You state that anaerobic bacteria do not act directly themselves as ferments?

A. No. At the time I prepared my book, I looked into that question with very great care, and my book takes exceptions to maybe all rules, but I am speaking of the rule in the light of the knowledge that I was able to acquire as a result of a dozen or fifteen months' investigation in 1911 or 1912. I don't follow closely all the literature on that line.

Q. Have you made examination of sludge yourself that were undergoing anaerobic decomposition changes?

A. In tanks I have given a good deal of attention to it.

Q. Did you ever find any oxygen in it?

A. No, not in the sludge that was undergoing decomposition.

Q. What are the products evolved from organic matter known as sewage, through anaerobic decomposition changes?

1379 A. The nitrogen of the organic matter is released into the atmosphere as nitrogen-gas substances. The hydrogen is released as hydrogen gas. The carbon is released largely as ordinary——

Q. Carbon dioxide?

A. No, CH_4.

Q. Methane?

A. Marsh gas. Methane is the chemical expression. Some carbon, a small amount of it may be released as an oxide, either CO_2 or CO, more particularly the latter. The sulphur is released as sulphuretted-hydrogen or complicated compounds that I don't remember the name of, but are capable of producing foul smells and capable of using up oxygen.

Q. How do those anaerobic bacteria affect the substances known as indol, skatol, cresol, cadaverin and the other putrefactive substances found in sewage sludge?

A. How do the anaerobic bacteria affect those?

Q. Yes.

A. I think they are instrumental in bringing about those substances which I understand are generally in the liquid stage or condition, as against those which I have earlier described, and are capable of getting into the gaseous stage.

Q. All those substances that are liberated through the

1380 functional activity of anaerobic bacteria, consume oxygen directly, do they not, and enter into direct chemical union with oxygen?

A. No, marsh gas does not. That is the principal gas, I presume, of the bubbling gas which you see on the surface of the water around a sewer slip in New York. I presume 75 or 80 per cent of the gas might be ordinary marsh gas, such as you would see in a mill pond. Hydrogen and nitrogen, of course, are not ordinarily

capable of using up oxygen, although they may be released in a form so that for a hundredth of a second after the interval of release they may be capable—that is, hydrogen may be capable of using up oxygen. Notrogen, I don't believe that would use up oxygen. The sulphur compounds would use it up, and so would some of those liquid products of a foul-smelling nature which you described. They probably would use some oxygen. I am not able to speak very precisely about that from memory.

Q. Would the carbon-monoxide, which you have mentioned use an atom of oxygen to make carbon-dioxide, in its transit through the waters over the sludge bed?

A. It would if the oxygen were in an atomic form, but I don't think it would use it in the molecular form in which it actually appears in water.

Q. Does oxygen occur in water when in solution as O2?

1381 A. I would say so, yes. I don't know just what you mean by that. I am rather rusty in remembering chemistry studied thirty years ago. If you have O3, as I understand, one of those oxygen atoms would produce atomic oxygen, and that would produce the actual oxidizing result; but if you have just a plain O2, you have, as I am carrying it in mind, molecular oxygen, and that will not combine very readily with organic substances.

Q. Does it exist in that condition?

A. It exists in the molecular form. You are rather off my beat when you talk chemical symbols. I will say this, that to take the polluted waters of the Niagara River with the sewage of Buffalo which goes over Niagara Falls, it is not capable of measurement regarding any diminution of the organic content. It shows that there are molecular oxygen contents there that don't produce any result.

Q. Mr. Fuller, in your analysis of sheet No. 3, which was offered by Professor Phelps during his testimony, you stated that the oxygen content found in the upper reaches of Newark Bay showed as 11 per cent, 6 per cent, and 5 per cent, and you regarded those as fluctuations, I understood?

1382 A. No, I intended to make plain that water in Newark Bay containing such low amounts of dissolved oxygen would have an effect in explaining fluctuations which might be found through a term of months and years in the oxygen content of New York Bay as they are considered during a term of months and years. I mean by that, that the contents of Newark Bay, its tidal prism, the volume of water above low tide is discharged to the extent of about 84 per cent through Kill van Kull; that is, it goes northward into the Upper Bay, and I am impressed with the fact that such a large volume of water, with such a low dissolved oxygen content, must have considerable bearing upon the oxygen content of the waters of the Upper Bay, so in the vicinity of Robbins Reef Light and thereabouts, but generally in the bay.

Q. What, if you know, is the oxygen content on the average of the lower reaches of Newark Bay?

A. I am not informed about that. This 11 per cent dissolved

oxygen content which is shown on this sheet 3 of Professor Phelps' analysis, dated July 22, of this year, was 11 per cent oxygen found in two samples taken near the Centerville Light; that is, as I recall, about half way between the Passaic Light and Shooters Island.

Q. What was the oxygen content, if you know, of the Kill
1383 van Kull on the average?

A. I don't know; I haven't studied the analysis of this year or any other year; I don't carry them in my mind. There were no samples taken in Kill van Kull, as I recall.

Q. Did you read Profesor Stearns' testimony given at these hearings in June?

A. I looked it over quite a number of weeks ago.

Q. Have you any reason to doubt his answer of 70 per cent. as the dissolved oxygen content of Kill van Kull?

A. No, I think he spoke of it as occurring quite a number of years ago. That is one of the things I carry in mind There has been a depletion in dissolved oxygen in the waters of the Upper Bay of New York to an extent greater than can be accounted for by the increase in pollution. In the Newark Bay there is a low amount of dissolved oxygen apparently during the month of July of 1919. It is a very much different story having a dissolved oxygen content of 6 or 5 or 11, from what Mr. Stearns spoke of in earlier years, that is, around 70 per cent.

Now, if the Newark Bay dissolved oxygen content should be about 70 per cent., I can see how the appearance at this particular summer period, with a dissolved oxygen content of 5 and 11 per
1384 cent. in Newark Bay how that would have quite an effect on the depletion in New York Bay. You have something there to take into account and explain, other than the increase in population directly tributary to New York Bay.

Q. Did you take into consideration the aeration or reaeration facilities of Newark Bay that would raise the oxygen content from 11 per cent. in the upper reaches to 70 per cent. as it entered the Kill van Kull?

Mr. Riker: The question is objected to on the ground that the point at which the determination of 11 per cent. was taken is not in the upper reaches of New York Bay, but on the contrary, is in the lower reaches of New York Bay.

Commissioner Maher: Note the objection of counsel for defendants.

A. No, I have not considered reaeration. I recognize that it is something of a factor, but as Professor Phelps says, it is not a very big one.

Q. How would it affect the waters in the Upper Bay of New York in the region of Robbins Reef—any condition of these waters in Newark Bay itself?

A. I perhaps haven't made myself clear. As I understand the situation, the facts are about like this that in the tidal prism of Newark Bay there are a thousand million cubic feet of water which
1385 has its low oxygen content, or at least it did have it on the 22nd of July, 1919, three-fourths at least, and as Mr. Parsons

says, 84 per cent. of ebb tidal flow of Newark Bay goes into the Upper Bay, and it would not all go to Robbins Reef Light district, but would get into the New York Bay district. If the Passaic Valley trunk sewer is put in service, and the pollution which directly or indirectly gets to influence the waters of Newark Bay, if all that pollution is taken care of in the trunk sewer, there will be a well oxygenated water in the future in Newark Bay, to go out through Kill van Kull into New York Bay. Now, then, if that oxygen ratio on the twenty-second day of July, in Newark Bay, were only 5 to 11 per cent. and if it should become 70, 80 or 90 per cent in the future, I believe that that would be quite an element to be taken into account in connection with the depletion of oxygen both in past and in future years.

Q. Did you take that oxygen determination showing 11 per cent. in Newark Bay as an average determining the oxygen content of Newark Bay?

A. I took it for just what the figures showed. It was determined twice. I don't know whether it would be 3 per cent., 12 or 13 per cent., as an average; I have no means of forming a guess; I
1386 took the figures at their face value; they spoke for themselves.

Q. At what condition of the tide were the figures taken?

A. The record will have to speak for itself; I think it was an ebb tide, but I can look it up, if you wish.

Q. I wish you would, and see if it wasn't the very end of the ebb tide, and was for the purpose of determining the very lowest per cent. of oxygen in those watrs.

A. It says "ebb tide," but I don't know what stage of the ebb tide it would be.

Q. Did you read Professor Phelps' testimony?

A. Yes.

Q. And that the determination was made when the odors were strongest and for the purpose of determining the percentage of oxygen in the waters at such time?

A. I don't recall that.

Q. Now, Mr. Fuller, what percentage of the waters of Newark Bay goes through the Kill van Kull and enters the Upper Bay of New York?

A. The figure which I have carried personally in mind for a good many years is 75 per cent. I see Professor Landreth said the bulk of the water from Newark Bay goes south through Arthur Kill. I think that must be an error in his testimony, or he misspoke himself. Mr. Parsons gives it as practically 84 per cent of the discharge of Newark Bay going through the Kill van Kull.

1387 Q. Haven't you got those figures reversed, for the Kill van Kull and the Arthur Kill, Mr. Fuller?

A. No, I looked up his paper here this morning. Here is a copy of volume 5 containing Professor Parsons' report. It must be misprint coming through a public document; he says definitely here in a paper which he gave before the American Society of Civil Engineers, in a note to his Table 5 "of the water entering and leaving

Newark Bay and tributaries, 83.66313 per cent passes Kill van Kull,"——

Q. What page is that?

A. I am reading from page 687 of the proceedings of the American Society of Civil Engineers, being a paper by H. De B. Parsons on "Tidal Phenomena in the Harbor of New York." I want to complete the sentence which I am reading as a note appearing at the foot of Table 5 on page 687 of the above proceedings.

"NOTE.—Of the water entering and leaving Newark Bay and tributaries, 83.66313 per cent passes Kill van Kull, and 16.33687 per cent passes the upper end of Arthur Kill."

Q. Does that include, Mr. Fuller, the water coming and leaving; does it include the volume of water coming on the flood and leaving on the ebb?

A. I presume so; it means just what it says; as far as I
1388 know, it is entering water and leaving water.

Q. Both are included in that?

A. Yes, separately and collectively.

Q. Assuming that to be correct, what percentage of the water in New York Bay would that represent?

A. The tidal prism in Newark Bay is, roughly, 1,000 million cubic feet, whereas in the Upper Bay of New York it is about 2,540 million cubic feet. That is, the ebb flow of Newark Bay is roughly 40 per cent of that of New York Bay, as testified to by Mr. Allen.

Q. Let me direct your attention for a moment, Mr. Fuller, to the testimony given by Professor Phelps, and I read from page 898 of the stenographic minutes taken at these hearings:

"On July 22nd, I made a trip up Newark Bay, between the hours of 10:00 a. m. and 1:00 p. m. The tide was nearing the end of the ebb. The water was noticeably discolored in the Kill van Kull, a fact attributed at first to local pollution, until it was observed that the discoloration was continuous and continuously increasing as we proceeded."

Does that refresh your memory as to the condition of the tide at which the sample was taken that gave 11 per cent as the oxygen content in the waters taken on the twenty-second of July, 1919, by Professor Phelps?

A. I presume that that is the fact, as stated there.

Q. Can you give any approximate idea of the cubic yards or other mode of measuring the sludge deposits upon the floor
1389 of the Upper Bay of New York?

A. No, I really don't know. I looked into all the available evidence in 1914, but I have not considered the matter since.

Q. Do you think it is feasible, Mr. Fuller, from a financial or other personal standpoint to dredge out all the sewage sludge from the Upper Bay of New York and the lower reaches of the Hudson River and the entire length of the East River?

A. No, I think it is not financially practical to remove all of it. I think there are places where the sludge is so thin or slight in depth that it is entirely out of range of reason to do it, but I do believe that where there are sludge banks of five or ten feet in depth of sludge, it is a workable proposition and financially practicable proposition. Where those sludge deposits are, I wouldn't attempt to say. You mentioned the East River. My thought was that there is very little sludge accumulation in the East River. In the lower portion of the East River the velocity is so high, it is swept out. A velocity of about 1.5 feet per second will move a fairly fresh deposit of sludge in New York Bay.

Q. Can you give any approximate idea of the extent of depth of sewage sludge deposits in the Upper Bay of New York?

1390 A. Not from memory. I know that there are sludge banks and there are sludge deposits of substantial depth around certain slips, but I cannot tell you enough from memory to make it worth while to attempt.

Redirect examination.

By Mr. Riker:

Q. You have produced here the report of the Metropolitan Sewerage Commissioners of New York, 1914, and at page 563, do you find any statement in regard to the amount of water passing the Kill van Kull from Newark Bay?

A. Yes.

Q Will you read what you find there?

A. "Of the waters entering and leaving Newark Bay and tributaries, about 84 per cent passes Kill van Kull and 16 per cent passes the upper end of Arthur Kill."

Q. Is that statement made by any particular person?

A. Yes, it is made by F. W. Perkins, Acting Superintendent of the Coast and Geodetic Survey, Washington, D. C., and appears in the letter addressed by him to Mr. George A. Soper, President Metropolitan Sewerage Commission, New York City. It is dated Washington, D. C., August 14, 1908.

Commissioner Maher: Note on the record that the taking of the testimony under the order of March 10, 1919, is closed.